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CHILD DEVELOPMENT

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NATIONAL RESEARCH COUNCIL
2101 CONSTITUTION AVENUE
WASHINGTON, D. C.

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PHYSICAL GROWTH FROM BIRTH TO TWO YEARS: II. HEAD CIRCUMFERENCE

PART I. A REVIEW AND SYNTHESIS OF NORTH AMERICAN RESEARCH ON GROUPS OF INFANTS

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A few years ago the writer began a series of studies intended to aggregate and systematize the available research materials on selected items of physical growth during infancy. The first of these studies dealt with stature, and was published as a monograph (20). The second treats head circumference, and has been prepared in the form of two papers.

The present paper - the first of the two on head circumference - presents a colligation of North American research to date for groups of infants. Its companion paper, to be published later, will bring together the studies made in North America on the growth of individuals. Readers should recognize that this division is merely a convenient device for reducing the problem to articles of journal length.

In its scope, then, the present paper is restricted anthropometrically to girth of the head (occipito-frontal circumference), chronologically to the first two postnatal years, geographically to North America, secularly to the period from 1850 to 1945 (all of the presently accessible data having been collected between these dates), and analytically to the study of groups. These delimitations should be kept in mind; they constitute the frame of reference within which the contents of the paper are written and its conclusions claimed to hold.

The organization of the paper is bipartite. First, the source materials are reviewed. Succinct presentation is made of the relevant problems, procedures, and findings from thirty-five North American investigations reported between 1853 and 1945. Three of these investigations were executed prior to 1900, twelve in the period from 1900 to 1925, and the remainder during the ensuing two decades. In six instances, source materials are drawn from previously unpublished studies. Secondly, the source materials are synthesized. Here, the major objectives are to integrate information on infant head girth (the information which has accrued from statistical study of groups of North

*Grateful acknowledgment is made to Prof. Julian D. Boyd for reading the manuscript and offering valued suggestions.

American infants over the past century) and to reveal (through alignment and intercomparison of materials not previously placed in juxtaposition) new items of knowledge inherent in the existing data. Among the problems given consideration are those of age, sex, lineage, socio-economic level, birth order, prematurity, diet, and disease. Insofar as the problems necessitate and the data are adequate, emphasis is placed both on average values and on variation within groups. Coincident with the central task of epitomizing and extending a specified sector of knowledge, reference is made to problems awaiting exploration or needing additional study.

Three further notations are pertinent. In describing each investigation attention is given to the size and leading characteristics of the sample, to the anthropometric technique employed, to the procedures followed in grouping the data for analysis, and to the statistical media used in deriving and presenting the results. As far as possible head girth values are reproduced at monthly ages between birth and three months, at quarterly ages between three months and one year, and at semiannual ages between one and two years; in a few instances (2, 4, 12) values at ages near these are accepted for review purposes and then, before being used comparatively, are corrected by graphic interpolation to represent the ages chosen. It may be assumed as beyond reasonable doubt that whenever an "average" is reported either the arithmetic mean or the median was computed; opportunely, it has been found (21, 28, 34) that there is no systematic difference at the infancy ages between mean head girth and median head girth.

Presentation of Source Materials

In 1853 Ramsay (24) published records for "cranial circumference" on a small group of "southern Negro" males two years of age. The sample was obtained in Georgia and consisted of four subjects. Description of the anthropometric technique was not carried beyond the statement that the measurements were "carefully taken with a neat graduated tape, in the presence of reputable persons" (24, p. 397).

HEAD GIRTH (cm.) OF NEGRO MALES MEASURED IN GEORGIA

Age	Number	Mean	Minimum	Maximum
24 mos.	4	48.7	47.0	50.5

Commenting on the data, Ramsay stated: ". . . they are the only effort I have seen in this direction" (24, p. 397).

Data for head circumference on 98 New York infants, probably White, were reported by Chapin (9) in 1894. The subjects ranged in age between birth and two years. They were ". . . all hospital cases, taken either from the Infant Asylum or the babies' wards, and many were thus much below par" (9, p. 650). No discussion was given of their racial stocks beyond reference to one subject as Polish. Head girth was obtained "by passing the tape horizontally around the head, passing over the glabella and a point just above the external occipital protuberance" (9, p. 649). The subjects were "carefully measured."

HEAD GIRTH (cm.) OF HOSPITALIZED INFANTS, PROBABLY WHITE

Age Group Midpoint	Range	Number	Mean
3 days	0 thru 6	9	34.7
18 days	7 thru 30	20	35.1
3 mos.	1 thru 4	27	37.7
6 mos.	5 thru 6	9	38.9
9 mos.	7 thru 10	13	42.1
12 mos.	11 thru 12	6	44.9
15 mos.	12 thru 17	8	46.8
21 mos.	18 thru 23	6	47.4

Twenty-seven of the 29 infants under one month of age were breastfed. Of the 27 between the ages of one and five months, 10 were "on breast."

Holt (14), in 1897, published averages for head circumference ("occipito-frontal measurement") at birth and at successive semiannual ages to two years. The birth values were determined from records on "four hundred and forty-six full-term infants taken in about equal numbers from the Sloane Maternity Hospital and the New York Infant Asylum" (14, p. 22). The number of observations employed at older ages was not indicated; probably these data were collected in private practice. No specific discussion was given of the socio-economic or ethnic characteristics of the total sample or of the newborn series.

HEAD GIRTH (cm.) OF PHYSICALLY NORMAL NEW YORK INFANTS

Age (mos.)	Males		Females		Male Average minus Female Average
	Number	Average	Number	Average	
Birth	251	35.5	215	34.5	1.0
6	...	43.5	...	42.2	1.3
12	...	45.9	...	44.6	1.3
18	...	47.1	...	45.9	1.2
24	...	48.2	...	47.2	1.0

For each sex, average head girth at two years was found to exceed that at birth by 12.7 cm. Growth in head girth was "most rapid during the first year, the increase being about four inches (10.0 cm.). During the second year the increase was about one inch" (14, p. 22).

In the 1903 edition of his textbook, Obstetrics, Williams wrote: "The greatest circumference of the head, which corresponds to the plane of the fronto-occipital diameter, is 34.5 centimeters" (36, p. 136). This average value was stated to have been derived from "measurements of a large number of heads just after birth" (36, p. 136). The data were probably obtained in Maryland on White infants. Williams called attention to "individual variations" above and below the average and made the following additional notation: "As a rule, boys have somewhat larger heads than girls, and the children of multiparae than those of primiparae" (36, p. 136).

Data for occipito-frontal circumference were analyzed by Fleischner (11), in 1906, on 500 infants "divided rather arbitrarily into well nourished, fairly well nourished, and poorly nourished classes" (11, p. 740). The subjects were "all under a year old" and "all hospital patients" at the New York Foundling Hospital, the Nursery and Child's Hospital, or the Sea-Side Hospital of St. John's Guild, New York City. Roughly 25 per cent were classified as well nourished, 35 per cent as fairly well nourished, and 40 per cent as poorly nourished. No indication was given of the number of infants at each age.

HEAD GIRTH (cm.) OF NEW YORK INFANTS OF THREE "NUTRITIONAL" GROUPS

Age (mos.)	Well Nourished	Fairly Well Nourished	Poorly Nourished
	Average Head Girth		
0.5	37.5	35.6	33.5
3.0	40.1	38.6	36.2
6.0	42.6	40.8	39.2
9.0	44.4	42.9	41.2
11.5	45.7	44.1	42.7
	Increase in Average Head Girth		
.5 to 6.0	5.1	5.2	5.7
6.0 to 11.5	3.1	3.3	3.5
.5 to 11.5	8.2	8.5	9.2

The "well nourished" Infants yielded an average head girth for the first month higher than that from the "poorly nourished" infants at three months. Similarly, the average for "poorly nourished" infants of the twelfth month was almost identical with that from the "well nourished" at six months. Age differences in the averages afforded increases "less in the well nourished than in the poorly nourished" (11, p. 747).

Whether viewed from the standpoint of making comparisons with other studies, or of drawing conclusions from differences between the three subgroups, Fleischner's study is seriously lacking in specificity. This follows since it is not known what range of conditions "hospital patients" encompassed, or to what extent the size of a child entered into his classification as well, fairly well, or poorly nourished. In the latter connection, mention was made of the "probability" that a "large majority" of the poorly nourished group was "premature" (11, p. 743).

Averages for head circumference at semiannual age intervals from birth to two years were reported by Macy (19) in 1912. The basic data were gathered from "examinations of 500 children" (19, p. 629). Neither the measurement technique nor the subjects were described. The latter were probably residents of New York City.

AVERAGES FOR HEAD CIRCUMFERENCE (cm.) AT SEMIANNUAL AGES

Birth	6 mos.	12 mos.	18 mos.	24 mos.
36.6	44.2	45.0	48.0	49.0

Macy considered these values "indicative of the general tendencies of growth" for head girth in infancy.

In 1914 Montague and Hollingworth (23) analyzed measurements of "occipito-frontal" girth "made immediately after birth." The data were obtained from "obstetrical histories of the New York Infirmary for Women and Children . . . a hospital situated on the lower East Side of New York City" (23, pp. 345-346). They were probably accumulated during the years 1910 to 1914. Records were rejected if marked "premature," "syphilitic," or "twin." The investigators "began in the files with the last infant born and proceeded to transcribe from the records the measurements of 1,000 consecutive males and 1,000 consecutive females" (23, p. 345). Socio-economically the subjects were "very homogeneous . . . there being very few from the economically well-to-do classes" (23, p. 346). Ethnically they were "extremely heterogeneous . . . with Hebrews, Italians, and Slavs predominating . . . [and] few Negroes, Turks, or Asiatics included" (23, p. 346). The measurements were taken "with a metal tape."

HEAD GIRTH (cm.) OF NEW YORK (LOWER EAST SIDE) INFANTS AT BIRTH

Sex	N	Mean	S.D.	V	Percentiles 25th	Percentiles 75th	Range
Males	1000	34.2	1.67	4.9	33.1	35.2	29.0 - 41.5
Females	1000	33.6	1.55	4.6	32.6	34.7	28.0 - 39.5

With respect to central tendency, male infants were larger than female infants. Males showed slightly greater absolute and relative variability. Fifty per cent of the head girth observations for each sex fell within a zone of 2.1 cm.

Grover (13), in 1915, published means based upon 123 records of head circumference for physically normal infants ranging in age from five days following birth through twenty-six months. Head girth was measured as "the greatest circumference obtainable" (13, p. 475). "Only children with a normal appearance were measured" (13, p. 474). The sample was drawn in Boston: "Most of the children were among the out-patients of the Children's Hospital . . . Some were bed patients in the wards. Others were measured at the milk stations of the Milk and Baby Hygiene Association, . . . at the Boston Lying-In Hospital," or as "private patients" (13, p. 473).

HEAD GIRTH (cm.) OF BOSTON INFANTS

Age Group Midpoint	Age Group Range (mos.)	Males N	Males Mean	Females N	Females Mean	Both Sexes N	Both Sexes Mean
1	0 thru 1	4	36.7	3	35.6	7	36.2
3	2 thru 5	7	38.6	9	37.7	16	38.1
6	4 thru 7	14	42.5	11	41.5	25	42.1
12	9 thru 14	11	44.6	12	44.9	23	44.8
18	15 thru 20	14	46.9	7	45.6	21	46.5
24	21 thru 26	14	48.2	9	48.3	23	48.3

Differences between means were found to be greater for the age period from three to six months than for that from one to two years.

Means for head circumference derived from measurement of 7,126 infants aged six months to two years were reported in 1916 by Crum (10). The data were collected in thirty-one states at Better Babies Contests sponsored by the Woman's Home Companion and Baby Health Conferences fostered by the American Medical Association. They were amassed between 1913 and 1916 "according to uniform rules." "The great majority of the children . . . were of American-born parents . . . of different stocks, including German, Irish, Swedish, some Italian, and some of various other races" (10, p. 336). Means were given at monthly intervals.

HEAD GIRTH (cm.) OF "BABY CONTEST" AND "HEALTH CONFERENCE" INFANTS

Age (mos.)	Males N	Males Mean	Females N	Females Mean	Male Mean minus Female Mean
6	259	44.1	176	42.9	1.2
9	211	45.8	183	44.7	1.1
12	284	47.1	228	45.9	1.2
15	215	47.8	197	46.6	1.2
18	181	48.4	178	47.1	1.3
21	159	48.9	142	47.6	1.3
24	201	49.3	160	48.2	1.1

These mean values were considered standards for normal, healthy American infants. On the one hand, the racial composition of the sample would tend to make it more representative than if infants of northwest European ancestry only had been included. On the other hand, infants brought to health conferences and "baby shows" (at many of which prizes were given) would probably be predominantly well developed.

The averages presented in Holt's 1897 edition of The Diseases of Infancy and Childhood (14) were revised by Holt and Howland (15) in 1919. At birth, the 1897 figures were duplicated in a tabulation given on page 22, but revised in a table afforded on page 19. Beyond birth, the revision sample, in common with the original, was not described as to size or selection. The data were probably accumulated in private pediatric practice, and possibly collected partly in New York and partly in Baltimore.

AVERAGE HEAD GIRTH (cm.) OF "HEALTHY" MALE AND FEMALE INFANTS

Age (mos.)	Males		Females	
	Initial (1897)	Revision of 1919	Initial (1897)	Revision of 1919
Birth	35.5	35.3	34.5	34.3
6	43.5	43.2	42.2	42.3
12	45.9	45.7	44.6	44.5
18	47.1	47.5	45.9	45.7
24	48.2	48.7	47.2	47.5

Compared with the averages published in 1897, the averages for each sex in the 1919 table were slightly lower at birth and higher at two years. Specific for males, the 1919 figures were lower at birth, six months and one year, higher at eighteen months and two years. For females, the earlier figures were higher at birth, one year and eighteen months, and the later figures at six months and two years. All differences were small.

In the eighth (1923), ninth (1926), and tenth (1933) editions of The Diseases of Infancy and Childhood the only change made was that for average head circumference of male infants at birth; this was given as 35.2 cm. The ninth edition carried the statement that the authors had utilized "about two thousand personal observations upon children from one to five years old, chiefly from private practice" (15, p. 19). It appears a reasonable inference that the number of head girth measurements at ages one year, eighteen months and two years approximated 100 for each sex.

In 1919 Taylor (32) reported a statistical reduction of measurements for head girth on 250 neonates, 125 of each sex, born 1914-17. The measurements were made at the University Hospital, Minneapolis - a charity hospital admitting primiparous women almost exclusively. All of the subjects were "normal and born at term" (32, p. 353). The mothers were approximately 40 per cent of Scandinavian descent, 40 per cent of other northwest European ancestry, and the remainder of Jewish or central European stocks. "The occipitofrontal circumference" was determined "with a steel millimeter tape" (32, pp. 353, 355). "Eighty-one per cent of the babies were measured on the fourth, fifth, or sixth day of life, none earlier than the second, and none later than the tenth" (32, p. 353).

HEAD GIRTH (cm.) OF MINNEAPOLIS NEONATES, PREDOMINANTLY FIRST-BORN

Sex	Median Age	N	Mean	S.D.	V	Percentiles 25th	Percentiles 75th	Range
Males	5 days	125	34.7	1.15	3.2	34.2	35.3	29.8 - 37.8
Females	5 days	125	34.1	1.23	3.6	33.4	34.8	30.6 - 36.8

In contrast with the earlier findings of Montague and Hollingworth (23), the females showed slightly greater variability than the males. Supplementary study was made of the relationship between head girth and stature. The coefficients obtained (Pearson product-moment method of correlation) were .77 for males and .79 for females.

Measurements of circumference for a small series of infant heads largely free from "birth moulding" were analyzed in 1922 by Calkins (8). The subjects were 27 full-term, living infants born by "cesarean section" or "breech extraction." They varied in stature between 48.0 cm. and 53.5 cm. - all were "born within two weeks of term, according to the menstrual history" (8, p. 126). Head girth was measured as the maximum perimeter "taken around glabella and inion" (8, p. 115). The determinations were made on the day of birth. "A very slight uniform pressure was used in all the measurements with the idea of entirely avoiding compression" (8, p. 116).

GIRTH (cm.) OF "UNMOULDED" INFANT HEADS AT BIRTH

Sex	N	Mean	Minimum	Maximum
Males	18	35.2	33.0	37.5
Females	9	35.1	33.4	38.5
Both	27	35.2	33.0	38.5

Attention is called to Calkins' description of the tension applied when determining head circumference. The majority of investigators have failed to discuss this aspect of their anthropometric technique; among the 20 per cent not chargeable with this omission, practice has ranged from "avoiding any compression" (8, 33) to drawing the tape tightly (5, 17, 21).

Talbot (30), in 1924, presented data for head girth collected on approximately 200 "clinically normal American children" between the postnatal ages of two weeks and two years. The subjects were claimed "not to represent exceptionally well nourished or poorly nourished children" and characterized as "average children within the accepted normal limits of height and weight for age" (30, p. 541). Roughly half were males and half females. They were apparently in residence at the "Directory for Wet-Nurses of the Boston Infants' Hospital" during 1915-17. "Conditions here were especially favorable for the collection of normal data, as the children, mostly breast-fed, were the offspring of resident normal wet-nurses" (30, p. 25). Head girth was measured "from occiput around the frontal bosses" (30, p. 543).

For each sex separately, the records on every individual for age (abscissa value) and head circumference (ordinate value) were "plotted on charts, and a smoothed curve drawn to indicate the trend of growth" (30, p. 541). Two points should be noted with the reference to these curves; they "do not represent mathematical averages" and, as published, they are difficult to read. The tabulation which follows gives five points through which the trend for each sex (as shown on pp. 543-544) is estimated to pass.

HEAD GIRTH (cm.) OF "NORMAL, HEALTHY" BOSTON INFANTS

Age (mos.)	Males		Females	
	Number of Subjects	Estimated Average	Number of Subjects	Estimated Average
3	20	39.4	15	38.4
6	25	42.6	25	42.3
12	15	46.8	25	46.0
18	15	48.5	15	47.8
24	10	49.2	10	48.8

That these figures must be regarded as no more than crude estimates of central tendency is attested by the fact that short trend lines intended as reproductions of a segment of each curve (31, p. 522) yield values for head girth at age three months of 44.8 cm. for males and 40.3 cm. for females.

A second study reported by Talbot (31) in 1924 dealt with the head circumference of infants "organically sound" but "from four to ten weeks premature" (31, p. 30). "The criteria used in establishing prematurity were weight, stature, and general considerations, such as facies, texture of the skin, undeveloped nails, cry, unstable temperature and history of expected birth" (31, p. 30). Head circumference was measured on 10 males and 10 females at varying postnatal ages between seven and forty-five days. The subjects were born 1920-22 and housed partly at the Boston Lying-In Hospital and partly at the Children's Department of the Massachusetts General Hospital. Three were measured at two ages.

HEAD GIRTH OF PREMATURE INFANTS AT POSTNATAL AGES 7 TO 45 DAYS

Age Group Mean (days)	Age Group Range (days)	N	Head Girth Mean (cm.)	Head Girth Range (cm.)	Stature Mean (cm.)	Stature Range (cm.)	Weight Mean (gm.)	Weight Range (gm.)
12	7-18	10	29.2	25.2-31.0	45.1	38.0-46.5	1660	1304-2098
30	21-45	15	30.9	28.0-32.4	45.1	38.0-47.7	1857	1191-2339

These means were found to be markedly lower than any of the available means for full-term infants of like postnatal ages.

Utilizing 394 different infants, Richdorf (26) accumulated nearly six hundred measurements of head circumference distributed almost equally in each of the first twelve postnatal months. The data, obtained with a steel millimeter tape, represented "the largest horizontal circumference passing about the frontal eminences and occipital portion of the head" (26, p. 26). They were subjected to statistical analysis in 1925. The subjects were characterized as (a) residents of Minneapolis, St. Paul, and Rochester, Minnesota, (b) "all Caucasian," with "the majority of Northern European extraction," and (c) all negative for congenital abnormality, prematurity, birth injury, acute and chronic disease, and "nutritional disorder." Their fathers were "skilled workmen, tradesmen, or professional men" (26, p. 14). With respect to diet and health care: "Medical attention and instruction in child care was available for the mothers . . . All mothers were urged to breast feed their babies. Solid food (cereal well cooked) was begun from the fourth to the seventh month, and vegetables about a month later . . . Orange juice was given in all cases . . . Cod liver oil and sunlight were recommended almost routinely" (26, pp. 15-16).

HEAD GIRTH (cm.) OF MINNESOTA URBAN INFANTS OF MIDDLE AND UPPER CLASSES

Age Group Midpoint	Age Group Range	N	Mean	S.D.	V	Percentiles 25th	Percentiles 75th	Range
				Males				
7 days	5 thru 9	20	35.0	1.06	3.2	34.0	36.0	32.8 - 37.5
6 wks.	4 thru 7	25	38.2	1.26	3.1	37.3	39.1	35.5 - 41.3
3 mos.	2 thru 3	50	40.6	1.53	3.8	39.4	41.6	37.0 - 44.0
6 mos.	5 thru 6	50	43.5	0.96	2.2	42.9	44.2	41.5 - 45.9
9 mos.	8 thru 9	49	45.4	1.20	2.6	44.6	46.2	43.0 - 49.0
11 mos.	10 thru 11	50	46.6	1.40	3.0	45.5	47.5	44.5 - 49.5
				Females				
7 days	5 thru 9	21	34.4	0.85	2.5	34.0	35.0	32.5 - 35.5
6 wks.	4 thru 7	25	37.5	0.89	2.2	36.7	38.2	36.2 - 38.7
3 mos.	2 thru 3	50	39.1	1.11	2.8	38.4	39.9	37.0 - 41.5
6 mos.	5 thru 6	50	42.3	1.33	3.2	41.5	42.9	39.2 - 44.8
9 mos.	8 thru 9	49	44.7	1.40	3.1	43.9	45.5	42.1 - 48.5
11 mos.	10 thru 11	48	45.6	1.31	2.9	44.7	46.2	43.2 - 48.8

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For the fifty subjects of each sex in the "6 mos." age group, supplementary study was made of head circumference in relation to head length and head breadth. On males, Pearson product-moment coefficients of correlation were .76 for circumference with length and .44 for circumference with breadth. Practically identical findings were obtained on females (r = .79 for circumference with length, r = .44 for circumference with breadth).

Means for head girth at three infancy ages - one week following birth, six months, and eighteen months - were obtained in 1926 by Swanson (29). The subjects were 90 White, "healthy normal" females examined 1924-25 in Minneapolis and St. Paul, Minnesota. They were obtained through hospitals, orphanages and homes. In compiling the neonate series, "prematurity [birth weight less than 2500 gms.], birth injury and congenital abnormalities were considered definite causes for rejection" (29, p. 13). At older ages, any gross pathology - deformity, malfunction, disease condition - was cause for rejection. The parents were about 70 per cent of British, Scandinavian or German descent and 30 per cent of central or south European ancestry. They varied "from the pauper to the upper class," the majority being "middle class" (29, p. 17). Measurement was made of "the largest horizontal circumference passing through the frontal eminences and the occipital protuberance" (29, p. 24); the tape was brought "snugly in contact with the skin all around" (29, p. 21). One anthropometrist, Swanson himself, took the entire series of records.

HEAD GIRTH (cm.) OF "TWIN CITIES" FEMALE INFANTS FROM MIDDLE CLASSES

Age Group Mean	Range	Number	Mean
7 days	0 thru 14	50	33.9
6 mos.	0.5 thru 11	50	40.8
18 mos.	12 thru 25	50	46.0

The difference between the means for ages one week and six months was greater than that between the means for ages six and eighteen months, i.e., the increase over the first six months of postnatal life exceeded that during the succeeding year.

In 1930, Baldwin, Fillmore and Hadley (4) reported an analysis of head circumference data for 232 infants between the ages of birth and thirty months living in a rural area. The data were collected during the years 1923-26 on infants residing in rural communities of east-central Iowa. Head circumference was taken with a steel millimeter tape as the maximum girth "over the frontal and occipital processes." Careful attention was given to the maintenance of vigorous standards of anthropometric procedure; the anthropometrists were "Mrs. Gladys Davis, Mrs. Laura Busby, Miss Edna Armstrong, Miss Dorothy Bradbury, and Mr. Elmer Olander."

HEAD GIRTH (cm.) OF IOWA RURAL INFANTS EXAMINED 1923-26

Age Group Midpoint	Range (mos.)	Males N	Mean	S.D.	V	Females N	Mean	S.D.	V
3	0 thru 5	16	41.4	2.3	5.6	12	39.4	2.1	5.3
9	6 thru 11	31	46.0	1.6	3.5	26	44.2	1.9	4.3
15	12 thru 17	36	47.6	1.3	2.7	20	46.2	2.4	5.2
21	18 thru 23	28	49.1	1.4	2.9	22	47.4	1.2	2.5
27	24 thru 29	23	49.7	1.3	2.6	18	48.3	1.0	2.1

Central tendency values at semiannual ages from six months to two years were derived by the reviewer, using the medium of graphic interpolation:

Age:	6 mos.		12 mos.		18 mos.		24 mos.	
Sex:	Males	Females	Males	Females	Males	Females	Males	Females
Head girth:	44.1	42.2	46.9	45.4	48.4	46.8	49.4	47.9

Also in 1930, Tiber (33) analyzed series of measurements of head girth taken within six hours after birth and at the end of the first postnatal week. The subjects were 208 "mature, healthy, Caucasian" neonates "delivered at the obstetrical department of the Ancker Hospital of St. Paul, Minnesota, in the winter of 1928-29" (33, p. 32). In selecting the subjects there were five criteria of exclusion: prematurity, physical abnormality, non-Caucasian ancestry, illness, and failure to survive the first week of postnatal life. From information on maternal age, ancestry and parity, it was found that one-third of the mothers were primiparae, two-thirds between eighteen and twenty-eight years of age, and four-fifths of northwest European stocks. Head girth was taken with a linen millimeter tape as "the greatest circumference passing through the glabella" (33, p. 35). Readings were made using "slight uniform pressure . . . for the purpose of removing any slack in the measuring tape and at the same time avoiding any compression of the part" (33, p. 38).

HEAD GIRTH (cm.) OF NEONATES BORN AT ST. PAUL 1928-29

Age	Males				Females			
	N	Median	Percentiles 25th	75th	N	Median	Percentiles 25th	75th
Birth	106	33.8	32.7	34.8	102	33.1	32.5	34.0
7 days	106	34.4	33.4	35.3	102	33.6	32.8	34.5

The median for males at birth was higher than that for females one week after birth. At both ages the central one-half of the records were encompassed within zones of 1.7 cm. for females and approximately 2.0 cm. for males.

The Iowa Child Welfare Research Station (16), in 1931, published a statistical study of records for head circumference distributed over the age period from two weeks to twenty-four and one-half months. The subjects were "Iowa infants," probably residents of east-central Iowa. Apparently they were obtained during the early 1920's at one-day clinics "held in various towns and cities in the state" and following 1925 through a permanent clinic at Iowa City. In determining the head girth a steel millimeter tape was passed "over the most prominent point on the occipital protuberance and . . . over the greatest prominences in the temporal and frontal regions" (16, p. 1142). Each record was based on determinations by two anthropometrists.

HEAD GIRTH (cm.) OF IOWA INFANTS

Age Group Midpoint (mos.)	Range	Males N	Mean	S.D.	V	Females N	Mean	S.D.	V
1	0.5 - 1.5	14	37.5			13	35.1		
2	1.5 - 2.5	22	39.3	1.38	3.5	6	37.6		
3	2.5 - 3.5	26	40.6	1.37	3.4	8	39.3		
6	5.5 - 6.5	40	44.3	1.63	3.7	19	42.7	1.62	3.8
9	8.5 - 9.5	32	45.2	1.27	2.8	24	44.5	1.48	3.3
12	11.5 - 12.5	26	47.1	1.49	3.2	25	45.5	1.18	2.6
15	14.5 - 15.5	17	47.5	1.23	2.6	14	45.9		
18	17.5 - 18.5	23	48.8	1.25	2.6	13	47.4		
24	23.5 - 24.5	17	50.0	1.13	2.3	23	48.2	1.32	2.7

The absence of variability values at certain ages follows, of course, from the fact that with samples of less than fifteen items such values were considered too unstable to merit calculation.

Head girth data on 100 full-term neonates were presented by Stebbins (27) in 1933. The subjects were born at the University Hospitals, Iowa City, during February and March, 1933; in every instance weight at birth exceeded 2500 gm. Their parents were described as "White, American," below average in socio-economic status. With the aid of a "standardized linen tape," head circumference was "taken with the tape over the greatest prominences of the frontal and occipital bones. An assistant held the tape in place at the back of the head" (27, p. 7). Each subject was measured on the second day (24 to 48 hours after birth) and again on the ninth day.

HEAD GIRTH (cm.) OF IOWA MECHATES OF LOWER CLASSES

Age (days)	N	Mean	S.D.	V	Minimum	Percentiles 10	25	50	75	90	Maximum
					Males						
2	50	34.6	1.00	2.9	32.6	33.3	34.0	34.6	35.1	35.9	37.3
9	50	35.0	1.02	2.9	33.1	33.5	34.4	35.0	35.5	36.4	37.4
					Females						
2	50	33.6	0.96	2.8	31.4	32.4	32.9	33.6	34.4	34.9	35.2
9	50	34.0	0.97	2.9	31.8	32.8	33.2	33.9	34.7	35.2	35.6

Comparable means were found to be one centimeter higher for males than for females. The mean for females at nine days was identical with the twenty-fifth percentile for males at two days. At both ages, 50 per cent of the male records fell within a zone of 1.1 cm. and 50 per cent of the female records within a zone of 1.5 cm. The range was greater for males than for females by 1.2 cm. at two days and 1.1 cm. at nine days.

In 1934 Bakwin and Bakwin (1) studied head circumference in relation to sex and order of birth utilizing a sample of "1653 new-borns." The subjects were White infants born at four New York City hospitals (Bellevue Hospital, Fifth Avenue Hospital, New York Nursery and Children's Hospital, and New York Infirmary for Women and Children) between about 1929 and 1934. Approximately 55 per cent were obtained through the Bellevue Hospital and 25 per cent through the Fifth Avenue Hospital. Infants born at the former were "almost exclusively from very poor homes," those born at the latter, "for the most part, from homes of moderate income" (1, p. 616). Head girth was taken as "the largest circumference of the head" (1, p. 371). "All measurements were made by Miss Allene Jones" (1, p. 612).

With reference to change in mean head girth during the early days of postnatal life, Bakwin and Bakwin stated: "The head measurements in this series of infants during the first 3 days of life showed no differences from means for the first 7 days of life and therefore all measurements are included in the calculations" (1, p. 612).

HEAD GIRTH (cm.) OF NEWBORN INFANTS "BY SEX AND ORDER OF BIRTH"

Sex	First-born Infants N	Mean	S.D.	V	Later-born Infants N	Mean	S.D.	V
Males	395	34.5	1.21	3.5	423	34.8	1.36	3.9
Females	417	33.9	1.34	4.0	418	34.1	1.17	3.4

Mean head girth was found to be "larger in males than in females and in later born than in first born infants" (1, p. 612). Disregarding birth order, means were obtained of 34.6 cm. for the 818 males and 34.0 cm. for the 835 females.

A comparative study of head circumference on premature and full-term infants was made by Mohr and Bartelme (22) in 1934. The data consisted of 158 head girth records on premature infants (birth weight less than 2500 gm.) and 30 comparable records on full-term infants. They were accumulated in Chicago during the period 1929-33. The subjects were White, native-born infants, about 30 per cent Jewish and 60 per cent of northwest European ancestry. Occupation of father, home ratings, and incidence of free hospital care showed them to "represent a slightly inferior socio-economic group" (22, p. 65). The premature infants were the recipients of "excellent" postnatal care and follow-up afforded by the Premature Infant Station, Sarah Morris Hospital of Michael Reese Hospital. The full-term infants were siblings of the premature infants.

In analysis, statutory age was used on the full-term subjects and, on those prematurely born, statutory age minus the estimated amount of prematurity. Separate analyses were made for full-term infants, for premature infants weighing 1000-1500 gm. at birth, for premature infants weighing 2000-2500 gm. at birth, and for the total sample of premature infants. The mean gestation period for the total premature group was approximately thirty-four weeks. Consequently, for this group, the ages given in the following tabulation are about six weeks less than average statutory age.

HEAD GIRTH (cm.) OF CHICAGO PREMATURE AND FULL-TERM INFANTS

Age (mos.)	Premature Infants: Birthweight 1000-1500 gm. N	Mean	Birthweight 2000-2500 gm. N	Mean	Total Premature Sample N	Mean	S.D.	V	Full-term Infants N	Mean
				Males						
3	2	36.8	1	36.8	5	36.6				
6	2	39.3	1	48.3	5	41.7			5	42.0
9	3	45.3	1	40.8	6	44.0			1	47.5
12			1	44.8	3	45.6			1	46.3
18	6	47.7	6	48.3	20	48.2	1.45	3.0	4	48.3
24	5	46.7	11	47.3	30	47.6	1.41	3.0	3	50.3
				Females						
3	1	42.3	1	37.8	5	38.1				
6	2	41.5	2	41.3	5	42.4			2	44.8
9	3	44.9			9	44.4			4	44.3
12	2	48.3	4	44.8	13	46.0	2.99	6.5		
18	6	48.3	6	47.8	28	47.2	2.62	5.6	8	46.2
24	5	46.4	10	48.4	33	47.8	1.75	3.7	2	48.3

The paucity of data at ages below eighteen months was acknowledged. At no age was the number of full-term infants adequate. Had the size of the samples been satisfactory, caution would still be necessary in any attempt to utilize the figures obtained in formulating an inference regarding the comparative rate of growth in head girth of full-term infants and infants born prematurely. This follows since for the premature infants age was corrected for the degree of prematurity and exceptional environmental provisions were made to facilitate growth. The investigators made the following summary statements: Premature infants "do not differ from the siblings in head circumference" (22, p. 96); "mean head circumferences for children who weighed 1,500 grams or less at birth remain consistently below the mean measurements for those weighing 2,000 grams or more at birth" (22, p. 103); and "measurements of head circumferences do not indicate persistence of large head circumferences as a result of megacephalus observed among the prematurely born children . . . some of the megacephalic children actually fall below the mean values for this measurement" (22, p. 103).

Stuart (28), in 1934, reported a statistical reduction of head girth data obtained on 119 White infants each measured one to eight times at ages between birth and two years. Collection of the data was prosecuted during the years 1930-34 by the anthropometric staff of the Center for Research in Child Health and Development, Harvard University. The subjects were born at the Boston Lying-In Hospital. All were "of American or North European parentage" and roughly half of Irish descent. None weighed less than "5 pounds at birth," none were "sick or clinically abnormal" (28, p. 199). Occupational classification of the fathers showed approximately 30 per cent to be unskilled or semiskilled, 50 per cent skilled, and 20 per cent of the managerial or professional classes. The examinations of the subjects included a comprehensive medical evaluation and afforded parents both general and individualized "advice as to feeding and care" (28, p. 31). With few exceptions, the "accepted immunizations" were "carried out at the appropriate ages" (28, p. 28).

Head circumference was taken "through the supraorbital ridges anteriorly and greatest occipital prominence posteriorly" (28, p. 200). At each examination measurements were secured by two anthropometrists, usually Vernette Vickers and Constance Shaw. Examinations were made within 48 hours following birth, within two days of two postnatal weeks, and within one week of ages, 3, 6, 9, 12, 18, and 24 months.

HEAD GIRTH (cm.) OF BOSTON MIDDLE CLASS, CLINIC SUPERVISED INFANTS

Age	N	Mean	S.D.	V	Minimum	Percentiles 10	25	50	75	90	Maximum
					Males						
Birth	50	35.4	1.3	3.7	32.4	33.7	34.5	35.4	36.0	37.3	38.0
2 wks.	33	36.3	1.2	3.3	33.9	35.0	35.5	36.3	37.0	37.9	38.2
3 mos.	50	41.0	1.3	3.2	38.6	39.2	40.1	41.0	41.8	42.7	44.0
6 mos.	45	44.9	1.1	2.4	41.8	42.5	43.3	44.2	45.0	45.7	46.0
9 mos.	41	46.0	1.1	2.4	43.6	44.4	45.1	46.1	46.7	47.4	48.4
12 mos.	37	47.2	1.0	2.1	45.1	45.6	46.5	47.3	47.9	48.6	49.3
18 mos.	34	49.1	1.2	2.4	47.0	47.4	48.1	48.9	49.8	50.9	51.2
24 mos.	26	50.0	1.3	2.6	47.8	48.2	49.1	50.1	50.9	51.7	52.0
					Females						
Birth	63	34.4	1.4	4.1	31.2	33.1	33.7	34.7	35.5	36.0	37.0
2 wks.	50	35.5	1.2	3.4	32.8	33.7	34.6	35.6	36.5	37.2	38.0
3 mos.	69	40.2	1.2	3.0	38.2	38.5	39.1	40.2	41.1	41.8	42.6
6 mos.	57	43.1	1.3	3.0	41.0	41.4	42.1	43.0	43.9	44.8	46.2
9 mos.	54	44.8	1.4	3.1	42.3	42.9	43.8	44.7	45.8	46.8	47.9
12 mos.	48	46.0	1.4	3.0	43.6	44.1	44.9	45.9	46.9	47.9	49.1
18 mos.	44	47.4	1.4	3.0	44.8	45.7	46.4	47.3	48.3	49.5	50.1
24 mos.	30	48.2	1.3	2.7	46.2	46.5	47.2	48.0	49.2	50.0	50.5

The mean given at age six months for males is seemingly a spurious value. It appears probable that the mean obtained was either 43.9 cm. or 44.3 cm.

In an investigation published in 1935, Bayley and Davis (5) presented an analysis of data for head girth accumulated on 60 infants of Berkeley, California. The subjects - normal infants born at two Berkeley hospitals 1928-29 and remaining reasonably healthy and well nourished throughout infancy - were measured repeatedly, many of them at sixteen different ages between birth and two years. Their parents were White, "English-speaking" people, predominantly of northwest European or early American stocks. They were interested in bringing their infants for periodic examination to the Institute of Child Welfare, University of California. The mean educational level of the fathers was 13.8 years; of the mothers, 13.1 years. The mean annual income was $2844, thirty per cent of the fathers being engaged in "professional or executive occupations." Examinations were made at "birth," at ("or within a few days of") each month of age from one to twelve, and at ages fifteen, eighteen and twenty-four months.

The technique employed in obtaining the birth measurements was not discussed. At older ages, head circumference was measured "with a linen tape graduated in millimeters, and having a spring attachment at one end by which the pressure could be kept constant" (5, p. 30). The tape was passed over the most posterior point in the occipital region and "over the greatest prominences in the temporal and frontal regions." Most of the measurements were taken by Bayley, a "few" by Dr. L. V. Wolff. "Every effort was made to overcome unreliability" (5, p. 31).

Indirect estimates of the reliability of the data were made using two approaches. First, ". . . fifteen infants in a San Francisco baby home, ranging in age from nine days to seven months, were measured, and then remeasured by Bayley after an interval of one week" (5, p. 34). It was found that the means and standard deviations from these two series of records were practically identical. Secondly, coefficients of correlation were obtained by successively pairing the measurements from one regular examination of the subjects with those taken at the next regular examination. The mean of these coefficients ($r = .92$) was considered to imply a "high degree of precision" (5, p. 33).

HEAD GIRTH (cm.) OF BERKELEY INFANTS EXAMINED 1928-31

Both Sexes

Age (mos.)	N	Mean	S.D.	V	Percentiles 25th	75th
Birth	53	35.0	1.88	5.4		
1	50	37.8	1.35	3.6	36.9	38.5
2	58	39.5	1.32	3.3	38.5	40.2
3	60	40.9	1.35	3.3	40.0	41.5
6	58	44.1	1.32	3.0	43.1	45.0
9	56	46.2	1.56	3.4	45.1	47.1
12	55	47.6	1.60	3.4	46.7	48.6
15	52	48.4	1.53	3.2	47.2	49.2
18	45	48.9	1.58	3.2	47.7	49.8
24	42	50.0	1.59	3.2	48.7	50.9

	Males				Females			
	N	Mean	S.D.	V	N	Mean	S.D.	V
Birth	28	35.5	1.15	3.2	25	34.5	1.38	4.0
1	24	38.6	1.19	3.1	26	37.1	1.22	3.3
2	31	40.1	1.13	2.8	27	38.8	1.19	3.1
3	31	41.5	1.20	2.9	29	40.2	1.06	2.6
6	30	44.9	1.17	2.6	28	43.3	1.16	2.7
9	27	47.0	1.15	2.5	29	45.4	1.29	2.9
12	28	48.5	1.30	2.7	27	46.8	1.36	2.9
15	27	49.3	1.38	2.8	25	47.5	1.10	2.3
18	22	49.8	1.30	2.6	23	48.0	1.28	2.7
24	24	50.7	1.43	2.8	18	49.0	1.15	2.4

At birth, the minimum and maximum records were reported. These were 33.3 cm. and 39.0 cm. for the male sample, 31.3 cm. and 37.0 cm. for the female sample.

Blatt and Schapiro (6) in 1935 studied "whether the circumference of the head has any relation" to inclusion of a special cereal mixture in the dietary of infants. The subjects were 136 "well" infants, ranging in age from three to twenty-three months. They were housed at St. Vincent's Infant and Maternity Hospital, Chicago, during the years 1931-33 and "observed for periods varying from six weeks to one year" (6, p. 325). "Cow's mild with dextrimaltose formed the basis of the infants' diets. A regimen of orange juice and cod liver oil was begun during the first month. Cereal became a dietary component when the infant was 3 months old. Vegetables and soups were given at 5 months. Eggs and puddings were added during the ninth month. At 1 year the children were receiving a general diet which included whole boiled milk, cereals, vegetables, soups, puddings, toast, eggs, bacon, stewed fruits, cod liver oil and orange juice" (6, p. 325).

Two groups were formed: a control series of 66 infants and an experimental series of 70 infants. The former "received the commonly used cereals," while the latter was fed "Mead's Cereal" - a mixture rich in vitamin B and minerals manufactured by Mead Johnson & Company. (The composition of the experimental cereal was as follows: "wheat meal (farina), 53 per cent; oatmeal, 15 per cent; bone meal, 2 per cent; dried brewer's yeast, 1 per cent; and alfalfa, 1 per cent." Its mineral content was "total ash, 3.2 per cent; calcium, 0.78 per cent; phosphorus, 0.62 per cent; iron, 0.024 per cent, and copper, 0.0013 per cent" (6, p. 324).) "All cereals were cooked with half milk and half water in a steam kettle for one-half hour and were fed as part of the morning meal. The quantity fed was dependent on the appetite of the child" (6, p. 325).

The subjects in each group were drawn "from the same social strata" and were "about equally divided as to sex" (6, p. 326). "There were 4 Negro children in each group" (6, p. 326). "Both groups were managed by the same nursing staff, and the diets differed only in the cereal given" (6, p. 325). On both groups the measurements of head girth were "made by the same physician," using a "steel tape" (6, p. 326). There were no subjects "with abnormalities of the head due to syphilis, rickets, hydrocephalus or microcephalus" (6, p. 331).

AVERAGE HEAD GIRTH (cm.) OF HEALTHY INSTITUTIONALIZED INFANTS ON CONTROLLED DIETS

	Months:						
Group	3	6	9	12	15	18	21
Experimental	39.4	41.7	43.6	44.8	45.8	46.7	47.7
Control	39.0	41.5	43.4	44.5	45.5	46.4	47.0

Blatt and Schapiro claimed they had compared "two groups of children in good health, living under as nearly ideal conditions as institutional life permitted," and found that "the group fed the special cereal mixture exceeded the control group in . . . circumference of head" (6, pp. 326, 336).

What are the implications of this study? It is the writer's view that the investigation presented no evidence in support of the inference that the special cereal mixture promoted growth in head girth. From the earliest age at which examinations were made through into the latter half of the second year, "the curves of the averages for both groups ran almost parallel" (6, p. 331). Moreover, as reported, the results cannot be considered to give dependable support to any statement regarding the relationship between growth in head girth and the vitamin and mineral content of the diet. This follows since no information was afforded on the numbers of subjects examined at each age, or on the numbers followed for six weeks only and for longer intervals to one year.

Central tendency and variability figures for head circumference were reported by Bakwin and Bakwin (2) in 1936 at eight ages during the first postnatal year. The data were obtained from 1,328 examinations made on 94 males and 104 females born at the Fifth Avenue Hospital, New York City, and "supervised from birth in a special clinic" for well infants. The subjects were characterized as White; mainly of North European, Mediterranean, and Jewish lineage; and "from homes of moderate income" (2, p. 177). Head girth was taken as "the largest circumference of the head."

HEAD GIRTH (cm.) OF NEW YORK CITY, MIDDLE CLASS, CLINIC SUPERVISED INFANTS

Age Group		Males			Females		
Midpoint (Wks.)	Range	Mean	S.D.	V	Mean	S.D.	V
2	0 thru 3	35.4	1.47	4.1	34.8	1.39	4.0
6	4 thru 7	37.7	1.32	3.5	37.0	1.38	3.7
12	8 thru 15	39.9	1.34	3.3	38.9	1.32	3.4
20	16 thru 23	41.8	1.20	2.9	40.9	1.22	3.0
28	24 thru 31	43.6	1.19	2.7	42.4	1.20	2.8
36	32 thru 39	44.8	1.40	3.1	43.8	1.09	2.5
44	40 thru 47	45.9	1.21	2.6	44.5	1.27	2.9
52	48 thru 55	46.5	1.31	2.8	45.5	1.11	2.4

The investigators omitted enumeration of the number of subjects in each age-sex group. They stated that the data yielded "no consistent differences" for infants of North European, Mediterranean or Jewish ancestry.

Measurements of head circumference obtained on 202 full-term infants of Japanese parentage were analyzed by Ito (17) in 1936. The infants were born 1932-35 in Los Angeles, California. About one-fifth of the mothers were American-born and approximately 56 per cent primiparae. Their average age was 25.2 years. The fathers were "laborers, farmers, horticulturists, clerks, small merchants, public officials and professional men. The majority were of the laboring class, but were comparatively well-to-do for Japanese in California" (17, p. 321).

All the subjects were measured during the first week of postnatal life, "the majority being measured on the third, fourth or fifth day" (17, p. 321). "Greatest circumference of the head - corresponding to the plane of the occipitofrontal diameter" - was taken by means of "a metal tape . . . with a Gulick spring handle attachment" (17, pp. 322, 323). The tension of the spring in the handle attachment was balanced against the spring in the coil case of the tape.

HEAD GIRTH (cm.) OF NEONATES OF JAPANESE ANCESTRY AND "BELOW AVERAGE" CLASSES

Age Group Midpoint (days)	Range	Sex	N	Mean	S.D.	V	Minimum	Maximum
4	0 - 7	Males	94	34.0	1.12	3.3	31.6	37.5
4	0 - 7	Females	108	33.8	1.24	3.7	28.0	37.0

For both sexes combined, the mean from this sample of Mongoloid infants was identical with that obtained by Montague and Hollingworth (23) from infants predominantly of White ancestry.

Joslin and Helms (18), in a 1937 paper, reported a study pertaining to the association between gain in head circumference and "amount of vitamin B complex in the diet" (18, p. 534). One hundred infants were followed "over a period of one year" through the pediatric clinic, University of Maryland, Baltimore. In initiating the study the infants were "placed alternately in two groups" as they were enrolled at the clinic. Both groups were "given the same basic diet, consisting of milk, water and carbohydrate, varied only as their ages demanded, with the addition of cereal and vegetables after six months of age" (18, p. 534). Their diets differed only in that one group received a special mixture of carbohydrate with vitamin B complex (Dextri-Maltose with vitamin B, manufactured by Mead Johnson & Company), while the other received "carbohydrate without additional vitamin B" (18, p. 535). The technique used in determining the head girth was not discussed.

VITAMIN B COMPLEX IN RELATION TO GAIN IN HEAD GIRTH (cm.) OVER ONE YEAR OF INFANCY

Vitamin B Group		Control Group		Vitamin B Gain minus Control Gain
N	Average	N	Average	
50	9.8	50	9.3	0.5

The difference in gain between the experimental and control groups was not tested for statistical significance. Consistent with this truncation of analysis, the investigators drew no conclusions claiming that growth of the head in infancy was increased "as the result of an increased amount of vitamin B complex given in the diet" (18, p. 538).

It was not made clear whether the experimental and control groups were matched for age. Each group was stated to have been followed for a year, but the year was not designated as extending from birth to twelve months of age. No more precise inference appears warranted than that the infants were probably under six months of age when accepted for study; this follows from the fact that their diets were started "when only milk and carbohydrate were being given" (18, p. 538). In the absence of explicit information on the age period(s) covered, and the extent to which the two groups were equated for age, the gains in head girth can neither be dependably interpreted nor compared with findings from other studies.

In 1938 Gesell and Thompson (12) published an analysis of head girth data representing each of the thirteen lunar month ages from eight to fifty-six postnatal weeks. Collection of the data took place 1927-31 at the Yale Clinic of Child Development, New Haven, Connecticut. The subjects - 49 males and 58 females - were "a normal, healthy, homogeneous group of white infants" (12, p. 11). All were full-term infants from "single births," 43 per cent being from "first pregnancies." All were "physically normal" and healthy. "Several cases of decided malnutrition were excluded" (12, p. 31). The parents were American-born and of "northern European extraction" (12, p. 26); they were "of the middle socio-economic status with respect to occupation, schooling, avocational interests, and home equipment" (12, p. 9) - their average years of schooling were 9.4 (fathers) and 9.8 (mothers), their intellectual and cultural interests were "near an average level"; in terms of Goodenough's six occupational categories they fell in categories III, IV, or V.

Head circumference was taken through "the glabella" anteriorly, and "the most prominent portion of the occiput" posteriorly. A steel tape was employed, its tautness being determined under the instruction "pull the tape until the first perceptible resistance is noticed" (12, p. 90). "With the exception of the infants less than 16 weeks of age" the measurements were "made by the same person" (Helen Thompson). As indicated previously, examinations were scheduled at lunar-month ages: "A variation of but two days from the exact age for each examination was the rule" (12, p. 9). "Some of the subjects were regularly and repeatedly examined, while others were seen only once" (12, p. 5).

HEAD GIRTH (cm.) OF NEW HAVEN "MIDDLE CLASS" INFANTS EXAMINED 1927-31

Age	Males					Females				
(wks.)	N	Mean	S.D.	V	Range	N	Mean	S.D.	V	Range
8	14	39.0	1.25	3.2	36.2-40.6	12	38.1	0.98	2.6	36.5-39.5
12	12	40.5	0.94	2.3	38.9-42.0	13	39.1	1.06	2.7	37.3-40.6
24	16	43.5	0.96	2.2	41.7-44.9	21	41.9	1.10	2.6	39.9-45.2
28	15	44.2	0.81	1.8	43.2-45.8	18	42.4	0.92	2.2	41.0-44.4
40	20	46.1'	1.16	2.5	44.1-48.8	17	44.0	1.22	2.8	42.3-46.6
52	19	47.3	0.85	1.8	45.4-48.5	24	45.0	1.08	2.4	43.3-47.9

	Increase in Mean				
	Twelve-week intervals:				Forty-eight wk. interval
	8-20	20-32	32-44	44-56	8-56
Absolute: Males	3.44	2.69	1.23	0.89	8.25
Females	3.12	2.07	1.25	1.26	7.70
Percentage: Males	8.8	6.3	2.7	1.9	21.1
Females	8.2	5.0	2.9	2.8	20.2

The differences between the means for successive twelve-week intervals were found to reflect a decreasing rate of growth with age.

In a 1939 study on the question of whether or not "constitution is a factor in the etiology of eczema in infants," Bakwin and Bakwin (3) compared the head girths of 126 eczematous infants and 775 control infants. Each group consisted of New York City White infants of mixed ethnic descent "from the same social economic environment" - "a low income one" (3, p. 270). The control subjects "were admitted to Bellevue Hospital as healthy boarders or because of mild upper respiratory infections and had received no regular medical supervision before admission" (3, p. 270). The experimental subjects were "infants with typical facial eczema . . . obtained from the wards or Out Patient Department of Bellevue Hospital" (3, p. 270). There were 433 males and 342 females in the control series, 86 males and 40 females in the experimental series. Head girth was taken as "the largest circumference of the head."

For the experimental data, there were few records at any one age; consequently, a method of analysis was sought which would avoid "the necessity of dividing up the material into age groups" (3, p. 269). Two graphs were constructed - one for males and the other for females - covering the first postnatal year. On each graph were plotted three trend lines derived from the control data: one drawn through mean values and the other two through points one standard deviation above and below the means. The records for infants with eczema were then spotted on these charts and tallied in terms of the zones within which they fell.

HEAD GIRTH DATA FOR INFANTS WITH ECZEMA REFERRED TO THE HEAD GIRTH DISTRIBUTIONS FROM A CONTROL SERIES

	-3 S.D.'s to -1 S.D.		-1 S.D. to Mean		Mean to +1 S.D.		+1 S.D. to +3 S.D.'s	
	N	%	N	%	N	%	N	%
Males	13	15	22	26	28	32	23	27
Females	6	15	9	23	13	32	12	30
Both sexes	19	15	31	25	41	32	35	28

Computation of chi-square showed the experimental data to differ significantly from the control data; accordingly, the conclusion was drawn that the infants with eczema were "larger" in head girth than the non-eczematous infants.

The head girth data analyzed by Stuart (28) in 1934 were extended and re-analyzed by Vickers and Stuart (34) in 1943. It will be recalled that accumulation of the data began in 1930 as part of a long-term study under the auspices of the Center for Research in Child Health and Development, Harvard University. The subjects "were principally of Northern European stock (a large proportion Irish), and the majority . . . were brought up in the vicinity of Boston in homes of low to middle economic circumstances" (34, p. 156). "Prematurely born infants and defective or chronically ill children were excluded" (34, p. 169). With few exceptions, the subjects were examined "repeatedly at fixed intervals"; examinations were made shortly following birth, within five days of ages three, six and nine months, and within approximately one week of ages twelve, eighteen and twenty-four months. Each examination included a comprehensive pediatric evaluation and supplied the parents with "health and nutritional advice."

HEAD GIRTH (cm.) OF BOSTON MIDDLE CLASS INFANTS UNDER PEDIATRIC GUIDANCE

Age (mos.)	N	Mean	S.D.	V	Minimum	Percentiles 10	25	50	75	90	Maximum
					Males						
Birth	99	35.3	1.2	3.4	32.6	33.5	34.4	35.3	36.2	37.0	38.0
3	125	40.8	1.2	2.9	38.2	39.2	40.0	40.9	41.5	42.1	44.5
6	117	44.0	1.0	2.3	41.8	42.7	43.3	43.9	44.8	45.4	46.3
9	115	45.8	1.0	2.2	43.1	44.5	45.1	46.0	46.5	47.1	49.0
12	113	47.1	1.1	2.3	43.4	45.5	46.5	47.3	47.8	48.4	49.3
18	108	48.8	1.1	2.3	46.2	47.3	48.0	48.8	49.4	50.1	51.8
24	102	49.6	1.2	2.4	46.0	48.1	48.7	50.0	50.4	51.2	52.0
					Females						
Birth	110	34.7	1.0	2.9	31.0	33.4	33.9	34.7	35.4	36.0	37.2
3	121	40.0	1.2	3.0	37.0	38.5	39.2	40.0	40.8	41.7	42.8
6	131	42.9	1.2	2.8	40.2	41.4	42.0	42.8	43.6	44.5	46.8
9	121	44.7	1.2	2.7	42.1	43.2	43.8	44.6	45.4	46.3	47.9
12	121	45.9	1.3	2.8	43.2	44.3	45.0	45.8	46.7	47.7	49.1
18	107	47.4	1.2	2.5	43.9	45.8	46.5	47.3	48.3	49.1	50.2
24	104	48.2	1.4	2.9	45.5	46.3	47.1	48.1	49.1	50.2	51.4

In measuring the head circumference, a cloth tape (checked frequently against a standard) was passed "over the most prominent part of the occiput and just above the supraorbital ridges" (34, p. 169).

A study was made by Meredith (21) in 1944 utilizing data for head girth accumulated over the decade 1930 through 1939 from developmental examinations of physically normal infants. The subjects were 1,050 White infants - 563 males and 487 females - ranging in age from two months to two years. They were almost all residents of Iowa City, Iowa, and upwards of 90 per cent were of northwest European ancestry. Information on occupation of the fathers showed 46 per cent to represent the professional and managerial classes, 28 per cent the skilled trades, and 26 per cent the unskilled and semiskilled groups.

The data were collected by, or in accordance with the technique of, Dr. Helen L. Dawson. A steel millimeter tape was placed around the infant's head by the anthropometrist ("measurer") and, with the aid of an assistant, adjusted "posteriorly over that part of the occiput which was farthest from the glabella. While the assistant held the tape in place posteriorly, the measurer adjusted it anteriorly above the supraorbital ridges, drew it tight, and read the measurement" (21, p. 199). In statistical reduction of the data, central tendency and variability findings were obtained at age two months, and at successive quarterly ages from three to twenty-four months. Only those head circumference records were accepted for tabulation which fell within five days of ages two and three months, and within seven days of the successive quarter-year ages.

HEAD GIRTH (cm.) ON IOWA INFANTS OF MIDDLE AND UPPER CLASSES STUDIED 1930-39

Age (mos.)	N	Mean	S.D.	V	Minimum	Percentiles 10	25	50	75	90	Maximum
Males											
2	35	38.9	1.08	2.8	36.3	...	38.2	...	39.7	...	41.0
3	112	40.6	1.05	2.6	37.8	39.2	40.0	40.6	41.2	41.8	43.6
6	205	43.7	1.26	2.9	40.4	42.2	42.9	43.7	44.5	45.4	47.2
9	249	45.6	1.24	2.7	42.6	44.1	44.7	45.5	46.4	47.2	49.2
12	258	46.8	1.29	2.8	43.6	45.1	45.9	46.7	47.6	48.5	50.3
15	225	47.6	1.24	2.6	44.8	46.1	46.7	47.6	48.5	49.2	51.1
18	204	48.3	1.22	2.5	45.8	46.7	47.5	48.3	49.1	49.9	51.7
21	170	48.8	1.21	2.5	46.2	47.2	47.9	48.8	49.6	50.4	52.0
24	186	49.3	1.19	2.4	46.7	47.9	48.4	49.3	50.2	50.9	52.3
Females											
2	25	38.2	1.34	3.5	35.6	...	37.3	...	39.0	...	40.5
3	93	39.4	1.24	3.1	36.3	37.9	38.7	39.4	40.2	41.0	42.1
6	180	42.4	1.26	3.0	38.8	40.8	41.6	42.4	43.2	44.0	45.2
9	226	44.2	1.19	2.7	41.1	42.8	43.3	44.2	45.0	45.8	47.2
12	238	45.4	1.28	2.8	42.3	43.8	44.4	45.4	46.3	47.2	48.5
15	212	46.2	1.23	2.7	43.2	44.6	45.4	46.2	47.1	47.9	49.0
18	204	47.0	1.23	2.6	43.9	45.3	46.0	46.9	47.8	48.6	49.6
21	164	47.5	1.25	2.6	44.5	45.8	46.6	47.5	48.5	49.1	50.4
24	165	48.0	1.21	2.5	45.0	46.4	47.1	48.0	48.9	49.6	51.0

Over the age period from three months to two years, supplementary means were obtained for both sexes combined. These values were used to derive age-to-age increments and thereby portray the trend in rate of growth.

HEAD GIRTH MEANS (cm.) FOR BOTH SEXES COMBINED, TOGETHER WITH QUARTERLY INCREASES IN MEAN HEAD GIRTH

Age (mos.)	N	Mean	Increase in Mean Absolute	Percentage
3	205	40.07		
6	385	43.08	3.01	7.5
9	475	44.91	1.83	4.2
12	496	46.09	1.18	2.6
15	437	46.94	0.85	1.8
18	408	47.60	0.66	1.4
21	334	48.16	0.56	1.2
24	351	48.67	0.51	1.1

Mean head girth at one year exceeded mean head girth at six months by 3.0 cm., or 7.0 per cent. Between ages one and one-half and two years, corresponding increments were 1.1 cm. and 2.2 per cent.

In 1945 Boyd (7) published an analysis of serial records for head circumference obtained on 100 "presumably normal" infants - 81 males and 19 females - housed in the metabolism ward of the Department of Pediatrics, University Hospitals, Iowa City. "All subjects were of the white native stock" (7, p. 71). "The majority were first-born children . . . of unmarried mothers" (7, p. 71). They were "recruited mostly from orphanages or from the maternity ward of the obstetric service of the State University of Iowa. . . . A significant number, however, were children of young university student couples, placed in the hospital because the mothers desired to continue employment outside the home" (7, p. 71). While various regimens of diet were employed, each was "designed to meet good standards of infant nutrition except for an experimental variation in the amount of vitamin D" (7, p. 71).

"Head circumference was determined through the use of a steel tape measure passed over the greatest prominence of the occiput and of the glabella" (7, p. 71). "Measurements were made by graduate nurses . . . trained in anthropometric technics" (7, p. 71).

HEAD GIRTH (cm.) OF IOWA INFANTS LIVING UNDER CONTROLLED CONDITIONS OF HOUSING AND DIET

Midpoint of Age Group (mos.)	Males				Females			
	N	Mean	S.D.	V	N	Mean	S.D.	V
1	55	36.0	1.4	3.9	16	35.0	0.8	2.3
2	65	38.4	1.4	3.8	17	37.2	1.3	3.4
3	71	39.5	1.4	3.5	16	38.5	1.2	3.1
6	64	42.4	1.2	2.7	15	41.2	0.8	1.9
9	24	44.3	1.1	2.5	4	42.7		
12	24	45.5	1.2	2.6	4	44.9		

The average difference between the means for males and females was found to be 1.0 cm. For males, the mean at one year exceeded the mean at one month by 9.5 cm., or 26.4 per cent.

An analysis of head girth data on 233 male infants, 134 White and 99 Negro, was reported in 1945 by Rhoads, Rapoport, Kennedy and Stokes (25). The data were collected between 1936 and 1940 through the "Out-Patient Department of the Children's Hospital of Philadelphia," each subject being measured at ages three months, one year, and two years. Infants were "classed as Negro where they had any known trace of Negro blood" (25, p. 437); the White infants were "in large proportion of northern European stock, with approximately one-fourth of Italian descent" (25, p. 416). All infants "had birth weights of 5 pounds or more," resided in urban families of "low socio-economic level," and were given dietary supervision beginning at the average age of six postnatal weeks.

From the time of the first examination all subjects received evaporated milk and orange or tomato juice. At six months the dietary included "banana, cereal, and pureed vegetables and fruits, and at 1 year, potato, meat, and egg" (25, p. 417). Four dietary subgroups were formed - the objective in this was to determine the influence of supplements of vitamins D, A, and B complex on the head girth of infants fed evaporated milk as their sole milk supply. Groups I, II, and III received "110 U.S.P. units of vitamin D daily in the form of irradiated evaporated milk"; Groups II and III also were given approximately 2,250 U.S.P. units of vitamin A daily in ten drops of carotene; and Group III received roughly 250 units of vitamin B_1 and 250 Sherman units of vitamin B_2 daily through the medium of brewer's yeast powder. Group IV was fed "nonirradiated evaporated milk plus 3 teaspoons of cod-liver oil daily" (25, p. 418). For all groups, visits were made to the homes every two weeks "in order to deliver the evaporated milk and vitamin supplements, and to keep in touch with the home care of the child" (25, p. 417).

There was no discussion of anthropmetric technique beyond a statement indicating that the procedure followed was the same as that of Vickers and Stuart (34), i. e., a cloth tape was passed over the most prominent part of the occiput and just above the supraorbital ridges.

HEAD GIRTH (cm.) OF PHILADELPHIA MALE INFANTS FROM "LOW INCOME" FAMILIES GIVEN DIETARY SUPERVISION

Group	N	3 mos. Mean	3 mos. S.D.	12 mos. Mean	12 mos. S.D.	24 mos. Mean	24 mos. S.D.	Increment (3 to 24 mos.) Absolute	Increment (3 to 24 mos.) % - age
				White Males					
I	48	40.0	1.37	46.4	1.50	48.8	1.45	8.8	22.0
II	24	40.1	1.09	46.3	1.14	48.7	1.34	8.6	21.4
III	20	39.7	1.50	46.3	1.39	48.8	1.45	9.1	22.9
IV	42	39.9	1.08	46.4	.94	49.0	.97	9.1	22.8
Total	134	39.9	1.27	46.4	1.27	48.8	1.30	8.9	22.3
				Negro Males					
I	32	39.8	1.14	46.1	1.42	48.4	1.24	8.6	21.6
II	17	40.1	1.30	46.5	1.14	48.9	1.52	8.8	21.9
III	19	39.7	1.06	46.1	.96	48.7	1.05	9.0	22.7
IV	31	39.8	1.58	46.1	1.95	48.4	1.85	8.6	21.6
Total	99	39.8	1.31	46.2	1.50	48.5	1.49	8.7	21.9

No statistically significant differences in head girth were found between any of the dietary subgroups at ages three months, one year, or two years. For the four dietary subgroups combined, at no age was the difference between the two racial groups of sufficient magnitude to support the inference that the White and Negro data represented random samples drawn from unlike head girth populations. On the total series of White males, the increase in mean head girth over the period from three months to two years was 8.9 cm., or 22.3 per cent; the corresponding values from the total series of Negro males were 8.7 cm. and 21.9 per cent.

Head girth data accumulated by the Child Research Council, University of Colorado, were made available in 1945 by Washburn and Redfield (35). The data represented measurements of fronto-occipital circumference on "average healthy" Denver infants examined repeatedly. They were collected between 1932 and 1944 on 54 males and 56 females, almost all of whom were of northwest European ancestry. Upwards of 90 per cent of the parents and 70 per cent of the grandparents were American-born. Around 30 per cent of the fathers placed in the professional or managerial groups, 60 per cent in the minor managerial or skilled trades groups, and 10 per cent among the semiskilled or unskilled.

HEAD GIRTH (cm.) OF DENVER INFANTS OF MIDDLE AND UPPER CLASSES

Age (mos.)	N	Mean	S.D.	V	Percentiles 25th	Percentiles 75th	Range
				Males			
Birth	9	34.7	...	...	...	...	33.0 - 36.6
1	20	37.2	1.3	3.6	36.5	37.9	34.6 - 39.3
2	19	38.8	1.2	3.0	38.2	39.6	36.2 - 40.8
3	35	40.4	1.2	3.0	39.7	41.3	38.3 - 42.6
6	42	43.4	1.2	2.7	42.6	44.2	41.0 - 46.3
9	38	45.3	1.0	2.2	44.7	46.1	43.0 - 47.1
12	40	46.6	1.0	2.1	46.0	47.3	44.2 - 49.2
18	41	48.3	0.8	1.7	47.9	48.9	45.9 - 50.0
24	40	49.3	0.9	1.8	48.7	49.9	47.6 - 50.9
				Females			
Birth	12	34.0	...	...	...	...	32.4 - 35.9
1	20	36.4	1.0	2.7	36.0	36.9	34.0 - 38.3
2	22	37.8	0.8	2.0	37.3	38.4	36.0 - 39.2
3	40	39.4	1.0	2.4	38.7	40.0	37.1 - 41.2
6	41	42.4	1.0	2.4	41.7	43.0	39.9 - 44.4
9	39	44.2	1.2	2.7	43.5	45.1	41.3 - 46.5
12	42	45.5	1.2	2.7	44.6	46.4	42.4 - 48.0
18	39	47.0	1.4	3.1	46.1	48.0	43.4 - 49.8
24	38	47.9	1.4	3.0	47.0	49.1	44.2 - 50.5

The means at two years of age exceeded those at birth by 14.6 cm. for males and 13.9 cm. for females. On each sex, the largest record at birth was practically equivalent to the smallest at age two months; similarly the largest record at three months was of nearly equal magnitude with the smallest at nine months.

Anthropometric Technique

Before turning to the problem of integrating the available materials for head girth on groups of North American infants, it is pertinent to interpose a discussion of anthropometric technique. How closely do the various series of data aggregated in the foregoing section approximate anthropometric comparability? Is it known, or can it be assumed, that in each study

reasonably careful attention was given to specification and rigorous application of the method of measurement and, consequently, to the dependability of the records amassed? Which collections of data represent a common procedure with respect to the anthropometric landmarks used and the tautness of the tape?

For seventeen of the thirty-five investigations there was little or no description of technique: Six indicated only that their data represented "cranial circumference" or "head girth" (6, 10, 18, 19, 22, 24); six used the designation "occipitofrontal circumference" (11, 14, 15, 23, 32, 36); and five stated that the "maximum girth" or "greatest circumference" had been measured (1, 2, 3, 4, 13).

Each of the other eighteen investigations made some direct reference to the landmarks employed. The posterior landmark was usually "the greatest prominence of the occiput" (5, 7, 8, 12, 16, 17, 21, 25, 26, 27, 28, 29, 34, 35): One investigator used "a point just above the external occipital protuberance" (9) and three studies were no more specific than "occiput" (30, 31, 33). There was less consistency regarding the anterior landmark(s). Several investigators measured "through the frontal eminences" (26, 29, 30, 31) and several "through the glabella" (7, 8, 9, 12, 17, 33).[1] It appears beyond doubt that the descriptions "over the greatest prominences in the temporal and frontal regions" (5, 16, 27) corresponded in practice with the descriptions "through the frontal eminences"; similarly, in instances where the anterior landmark was defined with reference to the supraorbital ridges (21, 25, 28, 34) the tape must have been passed in the region of the glabella. In two investigations, the same series of head girth data were described as having been taken "through the supraorbital ridges" (28) and "just above the supraorbital ridges" (34).[2]

[1] *In order to obtain an indication of the comparability of these landmarks during infancy, the writer made measurements at both levels on each of 50 White infants - 25 between 6 and 9 months of age and 25 between 18 and 24 months. It was found that mean head circumference "through the greatest prominence of the occiput and the frontal eminences" exceeded mean head circumference "through the greatest prominence of the occiput and the glabella" by 0.3 cm. on the younger group and by 0.4 cm. on the older group.*

[2] *Attention is called to the ambiguity of the words "above" and "over" in describing certain landmarks. With reference to the supraorbital ridges, these words may be interpreted as implying either "anterior" to the ridges or "superior" to them.*

Only seven of the available investigations discussed the tautness of the tape at the time head girth readings were made. In three instances "very slight" pressure was used (8, 12, 33) and in three the tape was drawn tightly (5, 17, 21). The seventh study was apparently intermediate, the tape having been brought "snugly" in contact with the head (29).

It need not be labored that in dealing with all problems of inter-comparison and colligation encompassed in the "Synthesis of Source Materials" which follows, the writer has made due allowance for the uncertainties and variations pertaining to the data. In this connection, those who make studies which involve pooling materials from different laboratories in order to derive comprehensive portrayals of the status of given sectors of knowledge become keenly aware of the need for moving toward anthropometric methods that are at once well-specified and standardized.

Synthesis of Source Materials

The initial step taken in synthesizing the source materials was that of compiling Tables 1 to 8. These tables afford an ordered display of the available averages for head circumference (exclusive of those on groups of infants born prematurely or having a specific disease) at eleven selected ages. Each average listed will be seen to represent infants of both sexes and to be accompanied by an abridged identification of the sample from which it was derived.

Average head circumference of nonpathologic White infants

In approaching this problem, two leading questions were asked: At each of several appropriately spaced ages, what is the average head circumference for physically normal White infants studied in North America to date? Over different age intervals, how much does the typical North American White infant increase in head circumference?

Answers to these questions were sought by pooling materials in Tables 1 to 8. Composite means were calculated representing monthly ages between birth and three months, quarterly ages from three months to one year, and semiannual ages between one and two years. At a particular age, the procedure followed was that of multiplying each average by the number of measures on which it was based, and dividing the sum of the resultant

TABLE 1

HEAD CIRCUMFERENCE AT BIRTH (Centimeters): Central tendency (mean or median) values from sixteen analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Tiber (1930)	33.5	208	Minnesota	1928-29	Mainly North European	"Mature, healthy" infants, measured "within six hours after birth."
Montague and Hollingworth (1914)	33.9	2000	New York	c.1910-14	Mainly South European	From middle and lower classes, measured "immediately after birth."
Ito (1936)	33.9	202	California	1932-35	Japanese	Mainly lower classes, 56% first-born measured during first postnatal week.
Stebbins (1933)	34.1	100	Iowa	1933	Mostly North European	Predominantly from lower classes, measured 24 to 48 hrs. after birth.
Baldwin and Baldwin (1934)	34.3	1653	New York	c.1929-34	White	From lower and middle classes, measured during first postnatal week.
Washburn and Redfield (1945)	34.3	21	Colorado	1932-44	North European	Mainly middle and upper classes, "average healthy" infants.
Taylor (1919)	34.4	250	Minnesota	1914-17	Mainly North European	"Charity" cases, "normal," mostly first-born, median age 5 days.
Williams (1903)	34.5	Number "large"	Maryland (?)	Before 1903	Probably White	Sample drawn to typify fronto-occipital circumference "just after birth."
Chapin (1894)	34.7	9	New York	c.1894	Probably White	Infants "below par," measured between birth and sixth postnatal day.
Holt and Howland (1919)	34.8	Over 400	New York, Maryland (?)	Before 1919	Probably White	"Healthy" neonates.
Stuart (1934)	34.8	113	Massachusetts	1930-34	North European	Largely from middle classes, 50% of Irish descent, measured within 48 hrs.
Holt (1897)	35.0	446	New York	Before 1897	Probably White	"Birth" measurements for normal, healthy subjects.
Bayley and Davis (1935)	35.0	53	California	1928-29	Mainly North European	From middle and upper classes, healthy infants measured "at birth."
Vickers and Stuart (1943)	35.0	209	Massachusetts	1930-42	Mainly North European	From middle and lower classes, measured within 48 hrs. after birth.
Calkins (1922)	35.2	27	Minnesota	c.1921	Probably White	Infants born by cesarean section or breech extraction, measured day of birth.
Macy (1913)	36.6	c.100	Probably New York	Before 1912	Probably White	Sample considered representative of normal infants at birth.

TABLE 2

HEAD CIRCUMFERENCE AT AGES ONE WEEK TO TWO MONTHS (Centimeters): Central tendency (mean or median) values from eighteen analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
				ONE WEEK		
Tiber (1930)	34.0	208	Minnesota	1928-29	Mainly North European	"Mature, healthy" infants; measured at end of first postnatal week.
Richdorf (1925)	34.7	41	Minnesota	c.1924	Mainly North European	From middle and upper classes; measured at ages 5 to 9 days.
Stebbins (1933)	34.5	100	Iowa	1933	Mostly North European	Predominantly from lower classes; measured on ninth postnatal day.
				TWO WEEKS		
Baldwin and Baldwin (1936)	35.1	c.190	New York	c.1929-35	White	From "homes of moderate income;" measured during first postnatal month.
Fleischner (1906)	35.2	c.75	New York	Before 1906	. . .	40% rated "poorly nourished" (some of these premature); age 2 weeks.
Stuart (1934)	35.8	83	Massachusetts	1930-34	North European, 50% Irish	Largely from middle classes; enrolled in child research and guidance clinic.
Chapin (1894)	35.1	20	New York	c.1894	Probably White	Infants "below par," measured at ages from 7 to 30 postnatal days.
				ONE MONTH		
Boyd (1945)	35.7	71	Iowa	1930-44	White	"Normal babies;" majority "first-born children . . . of unmarried mothers."
Grover (1915)	36.2	7	Massachusetts	Before 1915	Probably White	Mostly "out-patients," some "private," some "bed patients;" all "normal."
Iowa Child Welfare Research Station (1931)	36.3	27	Iowa	1920-29	Mainly North European	Data obtained in various urban areas of east-central Iowa; age 2 to 6 wks.
Washburn and Redfield (1945)	36.8	40	Colorado	1932-44	North European	Mainly middle and upper classes; normal subjects examined at age one month.
Bayley and Davis (1935)	37.8	50	California	1928-30	Mainly North European	From middle and upper classes; healthy infants measured at age one month.
				TWO MONTHS		
Boyd (1945)	38.0	82	Iowa	1930-44	White	"Normal babies;" majority "first-born children . . . of unmarried mothers."
Washburn and Redfield (1945)	38.3	41	Colorado	1932-44	North European	Mainly middle and upper classes; normal subjects examined at age two months.
Iowa Child Welfare Research Station (1931)	38.6	28	Iowa	1920-29	Mainly North European	Data obtained in various urban areas of east-central Iowa; age 6 to 10 weeks.
Gesell and Thompson (1938)	38.6	26	Connecticut	1927-31	North European	Of "middle socio-economic status," normal, healthy infants, age 8 weeks.
Meredith (1944)	38.6	60	Iowa	1930-39	Mainly North European	Iowa City infants drawn predominantly fro the middle and upper classes.
Bayley and Davis (1935)	39.5	50	California	1928-30	Mainly North European	From middle and upper classes, healthy infants measured at age two months.

TABLE 3

HEAD CIRCUMFERENCE AT AGE THREE MONTHS (Centimeters): Central tendency (mean or median) values from sixteen analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Chapin (1894)	37.7	27	New York	c.1894	Probably White	"Hospital cases," many "much below par;" measured at ages 1 to 5 mos.
Fleischner (1906)	38.0	c.75	New York	Before 1906	. . .	"Hospital patients," rated 40% "poorly nourished," some premature.
Grover (1915)	38.1	16	Massachusetts	Before 1915	Probably White	Mostly "out-patients," some "private," some "bed patients;" all "normal."
Talbot (1924)	38.9	c.35	Massachusetts	c.1915-17	White	"Average . . . normal, healthy" infants; mostly breast-fed.
Blatt and Schapiro (1935)	39.2	c.45	Illinois	1931-33	Mainly White, few Negro	Normal, "well" infants; fed a controlled (whole milk) diet.
Boyd (1945)	39.2	87	Iowa	1930-44	White	"Normal babies;" mainly fed a diet controlled to meet "good standards."
Baldwin and Baldwin (1936)	39.7	c.175	New York	c.1929-35	White	From "homes of moderate income;" mothers advised on infant care.
Richdorf (1925)	39.9	100	Minnesota	c.1924	Mainly North European	From middle and upper classes; pediatric guidance made available.
Washburn and Redfield (1945)	39.9	75	Colorado	1932-44	North European	Mainly middle and upper classes; normal subjects examined at age three months.
Iowa Child Welfare Research Station (1931)	40.1	34	Iowa	1920-29	Mainly North European	Data obtained at well-baby clinics in urban areas of east-central Iowa.
Gesell and Thompson (1938)	40.1	31	Connecticut	1927-31	North European	Of "middle socio-economic status;" physically normal and healthy.
Meredith (1944)	40.1	205	Iowa	1930-39	Mainly North European	Iowa City infants drawn predominantly from the middle and upper classes.
Vickers and Stuart (1943)	40.4	246	Massachusetts	1930-42	Mainly North European	From middle and lower classes; mothers advised on infant care.
Baldwin, Fillmore and Hadley (1930)	40.5	28	Iowa	1923-26	North European	From rural areas of east-central Iowa; measured at ages birth to 6 mos.
Stuart (1934)	40.5	119	Massachusetts	1930-34	North European, 50% Irish	Largely from middle classes; given pediatric guidance from birth.
Bayley and Davis (1935)	40.9	60	California	1928-30	Mainly North European	From middle and upper classes, reasonably healthy and well nourished.

TABLE 4

HEAD CIRCUMFERENCE AT AGE SIX MONTHS (Centimeters): Central tendency (mean or median) values from twenty-one analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Chapin (1896)	38.9	9	New York	c.1894	Probably White	See Table 3; ages 5 to 7 mos.
Fleischner (1906)	40.6	c.75	New York	1905 (?)	. . .	See Table 3.
Blatt and Schapiro (1935)	41.6	c.45	Illinois	1931-33	Mainly White, few Negro	"Well" infants, fed supplementary foods for vitamins D, C and B.
Boyd (1945)	42.0	77	Iowa	1930-44	White	See Table 3.
Grover (1915)	42.1	25	Massachusetts	1914 (?)	Probably White	See Table 3.
Talbot (1924)	42.5	c.50	Massachusetts	c.1915-17	White	See Table 3.
Bakwin and Bakwin (1936)	42.6	c.160	New York	c.1929-35	White	From middle classes; advised at a clinic on diet and health care.
Holt and Howland (1919)	42.8	c.200	New York Maryland (?)	Before 1919	Probably White	"Healthy" infants, probably seen in private pediatric practice.
Mohr and Bartelme (1934)	42.8	7	Illinois	1929-33	White	60% North European, from "a slightly inferior socio-economic group."
Holt (1897)	42.9	...	New York	Before 1897	Probably White	Data on normal, healthy infants; probably gathered in private practice.
Richdorf (1925)	42.9	100	Minnesota	c.1924	Mainly N. Eur.	See Table 3.
Washburn and Radfield (1945)	42.9	83	Colorado	1932-44	North European	Mainly middle and upper classes; normal subjects examined at age six months.
Gesell and Thompson (1938)	43.0	35	Connecticut	1927-31	North European	Of "middle socio-economic status," physically normal and healthy.
Meredith (1944)	43.1	385	Iowa	1930-39	Mainly N. Eur.	See Table 3.
Baldwin, Fillmore and Hadley (1930)	43.2	42	Iowa	1923-26	North European	Subjects resided in rural areas of east-central Iowa.
Vickers and Stuart (1943)	43.4	348	Massachusetts	1930-42	Mainly North European	From middle and lower classes, mothers advised on infant care.
Crum (1916)	43.6	435	Numerous	1913-16	Mainly N. Eur.	Baby show and health conference data.
Iowa Child Welfare Research Station (1)	43.7	59	Iowa	1920-29	Mainly North European	Data obtained at well-baby clinics in urban areas of east-central Iowa.
Stuart (1934)	43.9	102	Massachusetts	1930-34	North European	See Table 3.
Bayley and Davis (1935)	44.1	58	California	1928-30	Mainly North European	From middle and upper classes, reasonably healthy and well nourished.
Macy (1912)	44.2	c.100	New York (?)	1911 (?)	Probably White	Considered to typify age 6 mos.

TABLE 5

HEAD CIRCUMFERENCE AT AGE NINE MONTHS (Centimeters): Central tendency (mean or median) values from sixteen analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Chapin (1894)	42.1	13	New York	c.1894	Probably White	"Hospital cases," many "much below par;" measured at 7 to 11 mos.
Fleischner (1906)	42.6	c.75	New York	Before 1906	. . .	"Hospital patients," rated 40% "poorly nourished," some premature.
Blatt and Schapiro (1935)	43.5	c.45	Illinois	1931-33	Mainly White, few Negro	"Well" infants; fed whole milk plus other foods for vitamins and minerals.
Boyd (1945)	43.9	28	Iowa	1930-44	White	"Normal babies;" mainly fed a diet controlled to meet "good standards."
Bakwin and Bakwin (1936)	44.7	c.140	New York	c.1929-35	White	From "homes of moderate income;" mothers advised on infant care.
Washburn and Redfield (1945)	44.7	77	Colorado	1932-44	North European	Mainly middle and upper classes; normal subjects examined at age nine months.
Iowa Child Welfare Research Station (1931)	44.9	56	Iowa	1920-29	Mainly North European	Data obtained at well-baby clinics in urban areas of east-central Iowa.
Wohr and Bartelme (1934)	44.9	5	Illinois	1929-33	White	60% North European, from "a slightly inferior socio-economic group."
Gesell and Thompson (1938)	44.9	34	Connecticut	1927-31	North European	Of "middle socio-economic status;" physically normal and healthy.
Meredith (1944)	44.9	475	Iowa	1930-39	Mainly North European	Iowa City infants drawn predominantly from the middle and upper classes.
Richdorf (1925)	45.1	98	Minnesota	c.1924	Mainly North European	From middle and upper classes; pediatric guidance made available.
Baldwin, Fillmore and Hadley (1930)	45.2	57	Iowa	1923-26	North European	From rural areas of east-central Iowa; measured at ages 6 to 12 mos.
Vickers and Stuart (1943)	45.2	236	Massachusetts	1930-42	Mainly North European	From middle and lower classes; mothers advised on infant care.
Crum (1916)	45.3	394	Numerous	1913-16	Mainly North European	Infants measured at baby contests and health conferences.
Stuart (1934)	45.3	95	Massachusetts	1930-34	North European, 50% Irish	Largely from middle classes; given pediatric guidance from birth.
Bayley and Davis (1935)	46.2	58	California	1928-30	Mainly North European	From middle and upper classes, reasonably healthy and well nourished.

TABLE 6

HEAD CIRCUMFERENCE AT AGE ONE YEAR (Centimeters): Central tendency (mean or median) values from nineteen analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Fleischner (1906)	44.1	c.75	New York	1905 (?)	. . .	See Table 5.
Blatt and Schapiro (1935)	44.7	c.45	Illinois	1931-33	Mainly White, few Negro	"Well" infants; fed whole milk plus other foods for vitamins, minerals.
Grover (1915)	44.8	23	Massachusetts	Before 1915	Probably White	Mostly "out-patients," some "private," some "bed patients;" all "normal."
Chapin (1894)	44.9	6	New York	c.1894	Probably White	See Table 5, ages 11 to 13 mos.
Macy (1912)	45.0	c.100	Probably New York	Before 1912	. . .	Sample considered representative of normal infants at age one year.
Holt and Howland (1919)	45.1	c.200	New York Maryland (?)	Before 1919	Probably White	"Healthy" infants, probably seen in private pediatric practice.
Boyd (1945)	45.2	28	Iowa	1930-44	White	See Table 5.
Holt (1897)	45.3	...	New York	Before 1897	Probably White	Data on normal, healthy infants; probably gathered in private practice.
Baldwin and Baldwin (1936)	46.0	c.120	New York	c.1929-35	White	From "homes of moderate income;" mothers advised on infant care.
Gesell and Thompson (1938)	46.0	43	Connecticut	1927-31	North European	Of "middle socio-economic status;" physically normal and healthy.
Washburn and Radfield (1945)	46.0	82	Colorado	1932-44	North European	Mainly middle and upper classes; normal subjects examined at age one year.
Meredith (1944)	46.1	496	Iowa	1930-39	Mainly N. Eur.	See Table 5.
Baldwin, Fillmore and Hadley (1930)	46.2	56	Iowa	1923-26	North European	Subjects resided in rural areas of east-central Iowa.
Iowa Child Welfare Research Station (1931)	46.3	51	Iowa	1920-29	Mainly North European	Data obtained at well-baby clinics in urban areas of east-central Iowa.
Talbot (1924)	46.4	c.40	Massachusetts	c.1915-17	White	Subjects "clinically normal."
Stuart (1934)	46.5	85	Massachusetts	1930-34	North European	See Table 5.
Vickers and Stuart (1943)	46.5	234	Massachusetts	1930-42	Mainly North European	From middle and lower classes; given pediatric guidance from birth.
Crum (1916)	46.6	512	Numerous	1913-16	Mainly N. Eur.	See Table 5.
Bayley and Davis (1935)	47.6	55	California	1928-30	Mainly North European	From middle and upper classes, reasonably healthy and well nourished.

TABLE 7

HEAD CIRCUMFERENCE AT AGE EIGHTEEN MONTHS (Centimeters): Central tendency (mean or median) values from sixteen analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Holt (1897)	46.5	...	New York	Before 1897	Probably White	Data on normal, healthy infants; probably gathered in private practice.
Grover (1915)	46.5	21	Massachusetts	Before 1915	Probably White	Mostly "out-patients," some "private," some "bed patients;" all "normal."
Holt and Howland (1919)	46.6	c.200	New York Maryland (?)	Before 1919	Probably White	"Healthy" infants, probably seen in private pediatric practice.
Blatt and Schapiro (1935)	46.6	c.45	Illinois	1931-33	Mainly White, few Negro	"Well" infants; fed whole milk plus other foods for vitamins, minerals.
Mohr and Bartelme (1934)	47.0	12	Illinois	1929-33	White	60% North European, from "a slightly inferior socio-economic group."
Chapin (1894)	47.1	7	New York	c.1894	Probably White	"Hospital cases," many "much below par;" measured at 15 to 21 mos.
Baldwin, Fillmore and Hadley (1930)	47.6	53	Iowa	1923-26	North European	Subjects resided in rural areas of east-central Iowa.
Meredith (1944)	47.6	408	Iowa	1930-39	Mainly North European	Iowa City infants drawn predominantly from the middle and upper classes.
Washburn and Redfield (1945)	47.7	80	Colorado	1932-44	North European	Mainly middle and upper classes; normal subjects examined at age 18 mos.
Crum (1916)	47.8	359	Numerous	1913-16	Mainly North European	Infants measured at baby contests and health conferences.
Macy (1917)	48.0	c.100	Probably New York	Before 1912	Probably White	Sample considered representative of normal infants at age 18 mos.
Stuart (1934)	48.1	78	Massachusetts	1930-34	North European, 50% Irish	Largely from middle classes; given pediatric guidance from birth.
Vickers and Stuart (1943)	48.1	215	Massachusetts	1930-42	Mainly North European	From middle and lower classes; mothers advised on infant care.
Talbot (1924)	48.2	30	Massachusetts	c.1915-17	White	Subjects "clinically normal."
Iowa Child Welfare Research Station (1931)	48.2	36	Iowa	1920-29	Mainly North European	Data obtained at well-baby clinics in urban areas of east-central Iowa.
Bayley and Davis (1935)	48.9	45	California	1928-30	Mainly North European	From middle and upper classes, reasonably healthy and well nourished.

TABLE 8

HEAD CIRCUMFERENCE AT AGE TWO YEARS (Centimeters): Central tendency (mean or median) values from fourteen analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Holt (1897)	47.7	...	New York	Before 1897	Probably White	Data on normal, healthy infants; probably gathered in private practice.
Holt and Howland (1919)	48.1	c.200	New York Maryland (?)	Before 1919	Probably White	"Healthy" infants, probably seen in private pediatric practice.
Grover (1915)	48.3	23	Massachusetts	Before 1915	Probably White	Mostly "out-patients," some "private," some "bed patients;" all "normal."
Washburn and Redfield (1945)	48.6	78	Colorado	1932-44	North European	Mainly middle and upper classes; normal subjects examined at age two years.
Baldwin, Fillmore and Hadley (1930)	48.7	45	Iowa	1923-26	North European	Subjects resided in rural areas of east-central Iowa.
Meredith (1944)	48.7	351	Iowa	1930-39	Mainly North European	Iowa City infants drawn predominantly from the middle and upper classes.
Crum (1916)	48.8	361	Numerous	1913-16	Mainly North European	Infants measured at baby contests and health conferences.
Vickers and Stuart (1943)	48.9	206	Massachusetts	1930-42	Mainly North European	From middle and lower classes; mothers advised on infant care.
Macy (1912)	49.0	c.100	Probably New York	Before 1912	Probably White	Sample considered representative of normal infants at age two years.
Talbot (1924)	49.0	20	Massachusetts	c.1915-17	White	Subjects "clinically normal."
Iowa Child Welfare Research Station (1931)	49.0	40	Iowa	1920-29	Mainly North European	Data obtained at well-baby clinics in urban areas of east-central Iowa.
Stuart (1934)	49.0	56	Massachusetts	1930-34	North European, 50% Irish	Largely from middle classes; given pediatric guidance from birth.
Mohr and Wertelme (1934)	49.5	5	Illinois	1929-33	White	60% North European, from "a slightly inferior socio-economic group."
Bayley and Davis (1935)	50.0	42	California	1928-30	Mainly North European	From middle and upper classes, reasonably healthy and well nourished.

products by the total number of the measures.[3] Exclusions were made to avoid any duplicate use of measures and to eliminate studies on non-White infants. The specific omissions were as follows: For Table 1, Holt and Howland (1919), Stuart (1934) and Ito (1936); for Tables 3 and 5, Stuart (1934); for Tables 4, 6, 7 and 8, Holt (1897) and Stuart (1934). In Table 1 the number of measures for Williams' study was taken as 150. Table 9 gives the composite means obtained, together with the increases in mean for varying age intervals.

TABLE 9

HEAD CIRCUMFERENCE (Centimeters): Composite central tendency values for White infants of both sexes studied in North America during the period of 1890-1945, also increases in central tendency over specified age intervals.

Age (mos.)	Number	Mean	Increments: Monthly	Quarterly	Semi-annual	Annual
Birth	5226	34.3				
1	195	36.6	2.3			
2	295	38.6	2.0			
3	1239	39.9	1.3	5.6		
6	2193	43.0		3.1	8.7	
9	1791	44.9		1.9		
12	2166	46.0		1.1	3.0	11.7
18	1611	47.6			1.6	
24	1471	48.7			1.1	2.7

Selected findings from this table are:

1. Mean head circumference increases from 34.3 cm. (13.5 in.) at birth, through 46.0 cm. (18.1 in.) at one year of age, to 48.7 cm. (19.2 in.) at age two years. With reference to magnitude at birth, the increases are 11.7 cm. (4.6 in.), or 34 per cent, during the first postnatal year, and 14.4 cm. (5.7 in.), or 42 per cent, during the first two postnatal years.

2. Girth of head increases at a gradually slowing rate between birth and two years of age. The increase in mean for the first postnatal month is greater than that from six to nine

[3] *In mathematic symbolism, the formula used was*

$$M_c = \frac{N_1M_1 + N_2M_2 + \ldots + N_xM_x}{N_1 + N_2 + \ldots + N_x}$$

in which M represents arithmetic mean, N represents number of measures, subscript c refers to a combined or composite sample, and the numerical subscripts designate component samples.

months; similarly, the increase during the quarter-year from three to six months is greater than that for the entire second year. In percentage terms, the mean at one month exceeds the mean at birth by a larger amount (6.7 per cent) than the mean at two years exceeds that at one year (5.9 per cent).

These findings provoke a further question: Is there a simple mathematic relationship in infancy between age and average head circumference? Employing curve-fitting procedures, a noncomplex algebraic equation was sought which would closely "fit" the series of means at different ages shown in Table 9. It was found that for the period from one month to two years the data were best graduated by the empirical equation

$$\text{Head girth} = 36.36 \times x^{.0933}$$

in which "x" symbolizes "postnatal age in months." An indication of the "goodness of fit" is afforded by the following tabulation:

	Age in Months:				
	1	6	12	18	24
Obtained means (from Table 9)	36.6	43.0	46.0	47.6	48.7
Predicted means (from equation)	36.4	43.0	45.9	47.6	48.9
Difference	- 0.2	0.0	- 0.1	0.0	+ 0.2

Secular differences in head circumference

In the case of infant stature, it is known that over the past several decades the direction of the secular trend has been upward in North America. A recent examination of stature materials has led to the conclusion, "the average two-year-old child may be taken as at least four centimeters (one and one-half inches) taller for 1940 than for 1880" (20, p. 15). Has there been a parallel increase in head circumference? Casting the question in a form specifically suited to the available data, is there a difference in head girth between those infants studied prior to 1927 and those studied 1927-1945?

For consideration of this problem, the frame of reference was again restricted to full-term, nonpathologic, White infants. In addition, analyses were carried out only at ages affording no less than 500 measures for each period.

Utilizing Table 1 and Tables 4 to 8, composite means for the periods 1890-1926 and 1927-1945 were secured at each of six ages. In amassing the studies at a given age according to the period in which their data were collected, rejections were made to avoid duplicate use of records and to eliminate studies using records accumulated partly in each period. For Table 1, the

rejections were Holt and Howland (1919) Stuart (1934) and Ito (1936); for Tables 4, 6, 7 and 8, Holt (1897), Stuart (1934) and Iowa Child Welfare Research Station (1931); for Table 5, Stuart (1934) and Iowa Child Welfare Research Station (1931). The composite values obtained are presented in Table 10.

TABLE 10

HEAD CIRCUMFERENCE (Centimeters): Composite means for White infants of both sexes studied in North America during the periods 1890-1926 and 1927-1945.

Age (mos.)	1890-1926 Number	1890-1926 Mean	1927-1945 Number	1927-1945 Mean	Later Mean – Earlier Mean	Significance Ratio (t)
Birth	2982	34.2	2244	34.3	0.1	1.4*
6	1036	43.1	1098	43.0	– 0.1	1.3
9	637	44.9	1098	44.9	0.0	...
12	1012	45.9	1103	46.2	0.3	4.3
18	770	47.5	805	47.8	0.3	3.8
24	749	48.6	682	48.8	0.2	2.8

*Computation of these ratios necessitated estimates of the variability of head girth. Composite standard deviations were calculated for each age using all of the standard deviations on samples of White infants reported. For a statement of the formula employed see footnote 10. The composite figures derived -- representing White infants of both sexes -- were 1.5 cm. at birth (N = 4,265) and three months (N = 1,161); 1.4 cm. at six (N = 1,204) and nine (N = 1,253) months; 1.5 cm. at twelve (N = 1,295) and eighteen (N = 824) months; and 1.4 cm. at twenty-four months (N = 896). At a given age, the composite sigma was taken to depict the variability in each secular period.

It will be seen that:

1. During the first year of postnatal life, there is no systematic difference in head girth between those infants studied in the period 1890-1926 and those studied in the period 1927-1945.

2. For the second postnatal year, infants measured between 1927 and 1945 tend to be slightly larger in head girth than infants measured 1890-1926. While the differences are small - at no age exceeding 0.3 cm. (one-eighth inch) - they are consistent in direction and statistically significant (t exceeds 2.6 in each instance).

The reader is cautioned that these findings must not be glibly interpreted as paralleling those established for stature. The maximum difference of 0.3 cm. in head girth is no more than one-tenth the stature difference over the same secular interval. This markedly smaller magnitude of head girth differences, together with the incomplete description of many series of data, makes it impossible to distinguish the operation of differential factors associated with secular period from the presence of slight sampling differences for the two periods in such variables as ethnic and socio-economic composition or anthropometric

technique. For example, it cannot be shown unequivocally that factors associated with secular period are either (a) overshadowed by uncontrolled variables at age nine months, or (b) responsible for the difference obtained at one year. It follows that the only generalization on secular variation the existing data are adequate to support is that if there was a trend toward larger head girth over the period from 1890 to 1945, the rate of rise was small and the total amount of increase too slight to be of practical significance for the pediatrician.

Racial differences in head circumference

Are there differences in head girth among North American infants of White, Negroid and Mongoloid ancestry? Do White infants of northwest European lineage differ in head girth from those of southeast European descent? Materials relating to these questions are decidedly limited.

For Mongoloid infants, a single study is available. Ito (17) has reported a mean head girth of 33.9 cm. on 202 neonates of Japanese ancestry born in California. The subjects were drawn mainly from the lower classes. When aligned with the composite mean for White infants from Table 9, and with the Bakwin and Bakwin mean for White infants of the lower and middle classes from Table 1, Ito's mean is found to be 0.4 cm. lower in each instance.[4] On further comparison with studies for White infants representing a "below average" socio-economic level (see Table 1), Ito's mean is identical with the Montague and Hollingworth mean from infants predominantly of southeast European ancestry and 1.1 cm. less than the Vickers and Stuart mean from infants predominantly of northwest European ancestry. The conclusion indicated is that the mean head circumference of American-born neonates of Japanese lineage is similar to that for neonates of southeast European stocks, but smaller than for those of northwest European stocks.

For Negro infants, there are two studies - both on males. A mean head girth at two years of age from a sample of four "southern Negro" (Georgia) males is accessible from Ramsay (24). Means at three months, one year, and two years have been published by Rhoads and others (25) on 99 "northern Negro" (Pennsylvania) males of "low socioeconomic level" fed a prescribed diet.[5] Table 11 places these studies in juxtaposition

[4] *Both differences are statistically significant at the 1 per cent level of confidence (t = 4.0 and 3.8).*

[5] *Evaporated milk with supplementary vitamins C and D from six weeks after birth, cereal added in the fourth month, puréed vegetables and fruits in the sixth month, meat and eggs in the ninth month.*

with composite means for White males (see Table 24), means for the White counterpart of the study by Rhoads and others, and means from the Vickers and Stuart study (34) on White males principally from the middle classes and of northwest European descent. While the Vickers and Stuart sample differs a little in socio-economic and ethnic composition from that of Rhoads and others, the two studies are similar for anthropometric technique and dietary of the subjects.

TABLE 11

HEAD CIRCUMFERENCE (Centimeters): Means for Negro male infants compared with selected means for White male infants.

Racial Group		3 mos.		12 mos.		24 mos.	
		Number	Mean	Number	Mean	Number	Mean
Ramsay (1853): Negro						4	48.7
Rhoads & others (1945):	Negro	99	39.8	99	46.2	99	48.5
	White	134	39.9	134	46.4	134	48.8
Vickers & Stuart (1943): White		125	40.8	113	47.1	102	49.6
Composite White (see Table 24)		724	40.4	1145	46.7	856	49.2

Examination of Table 11 shows the Negro means to be surpassed by the White means at all three ages. For the Negro and White counterparts of the study by Rhoads and others the differences are slight and not statistically significant. Differences appreciably larger, and statistically significant throughout,[6] accrue from comparison of the Negro series of Rhoads and others with each of the remaining White series.[7]

Can it be inferred that North American Negro and White infants, if drawn from similar socio-economic backgrounds and given the same health care, do not differ in head circumference? Or, does head girth tend to be smaller for the Negro infant than for the White infant? To reply to either of these questions affirmatively would be hazardous in the absence of further clarification and pending additional research. The questions require that the intended connotation of the words "White" and "Negro" be specified, thereby affording a clear frame of reference covering the amount of White admixture encompassed by

[6] *The t values lie between 4.0 and 5.9.*

[7] *In this connection it must not be overlooked that some systematic factor(s) may be operating in the study of Rhoads and others to yield both Negro and White samples which are atypically small for head circumference.*

"Negro" and the proportions of various White subgroups symbolized by "White." From the standpoint of research materials relating to the questions, it has been indicated above that the only substantial data presently available are those from one study for male infants of the lower classes - here, the White group is "in large proportion of northern European stock, with approximately one-fourth of Italian descent," while the Negro group includes infants with "any known trace of Negro blood" (25, pp. 416, 437). Head girth investigations for North American Negroes are lacking on newborn infants of both sexes, on females at all infancy ages, and on all but one socio-economic level.

For White infants predominantly or exclusively of northwest European ancestry, several studies are available. Except at birth, however, there are no materials on infants of southeast European lineage with which they may be compared. At birth, the only study known to be based predominantly on subjects of southeast European lineage is that of Montague and Hollingworth (23). These investigators obtained a mean of 33.9 cm. (see Table 1) on 2,000 infants of the lower to middle classes born in New York City. For comparison, the study by Vickers and Stuart (34) best satisfies the two-fold criterion of being similar in socio-economic selection and known to be based predominantly on subjects of northwest European descent. This study, utilizing 209 Boston neonates of the middle to lower classes, yielded a mean higher than that of Montague and Hollingworth by 1.1 cm. The difference is statistically significant ($t = 9.4$), allowing the inference that neonates of southeast European ancestry tend to be smaller in head circumference than neonates of northwest European ancestry.

Socio-economic differences in head circumference

What is the relationship between the head circumference of infants at birth and the socio-economic status of their parents? At older infancy ages, are offspring from the indigent and unskilled groups smaller in head girth than offspring from the managerial and professional classes? These questions are conveniently considered in the same order as stated.

At birth, studies known to be based on White infants representing a "below average" socio-economic level are those of Bakwin and Bakwin (1), Montague and Hollingworth (23), and Stebbins (27). Ethnically, the first study typifies "mixed White stocks"; the second, "mainly southeast European descent"; and the third, "mainly northwest European descent." Only in the case of subjects mainly of northwest European descent are there investigations - Bayley and Davis (5), Washburn and Red-

field (35) - representing an "above average" socio-economic level. Compared with the mean from Stebbins of 34.1 cm. for "lower classes" (see Table 1), the combined mean from these "above average" data is higher by 0.7 cm. The significance ratio is sufficiently large ($t = 3.0$) to allow the generalization that head girth at birth averages slightly more on offspring from the professional classes than on those from the laboring classes. It must not be overlooked that this generalization rests solely on data for White infants of northwest European lineage.

At ages from three months to two years, the only investigation representing a "low income status" is that of Rhoads and others (25) for males. It will be recalled that this investigation affords means at three months, one year, and two years on 134 White males "in large proportion of northern European stock." For comparison with this series of means, an attempt was made to assemble other series which would be comparable for age, sex, and ethnic selection but portray different socio-economic levels. The procedure was that of pooling acceptable male data by age and socio-economic level. To represent the middle classes data were combined from Bakwin and Bakwin (2), Gesell and Thompson (12), and Vickers and Stuart (34). Data from Bayley and Davis (5), Meredith (21), Richdorf (26), and Washburn and Redfield (35) were pooled as characterizing a somewhat higher level (middle-to-upper classes). The means on each socio-economic group are aligned in Table 12.

TABLE 12

HEAD CIRCUMFERENCE (Centimeters): Means for White males representing three socio-economic levels. For all categories the subjects are mainly of northwest European ancestry.

Age (mos.)	Lower Classes		Middle Classes		Middle-to-upper Classes	
	Number	Mean	Number	Mean	Number	Mean
3	134	39.9	222	40.6	228	40.7
12	134	46.4	192	46.9	326	46.9
24	134	48.8	102	49.6	250	49.4

Findings from this table are:

1. The male infants of the middle classes practically coincide in mean head girth with the male infants depicting a somewhat higher level. What differences occur are not consistent in direction and appear soundly appraised as negligible in size.

2. Compared with the means representing the middle and middle-to-upper classes, the means on male infants of the low-

er classes are consistently and appreciably lower. With specific reference to the samples drawn from the middle classes and the lower classes, the differences at successive ages yield t values of 4.9, 3.6, and 4.8.

Although Table 12 leads to the conclusion that infants at the upper end of the socio-economic continuum have a larger average head circumference than those at the lower end, it does not afford an estimate of the magnitude of the difference. To derive such an estimate would necessitate representative samples drawn exclusively from the indigent and the wealthy groups (i. e., from narrow terminal segments of the socio-economic distribution). In Table 12, the "lower" category comprises infants under continuous dietary supervision and the "middle-to-upper" category encompasses approximately half the entire continuum.

Head girth in relation to diet

Is there a positive association between rate of growth in head circumference and early inclusion in the dietary of supplementary vitamins and minerals? Does the head girth of infants enrolled in a program of pediatric guidance tend to exceed that of infants drawn without reference to adequacy of diet or of other aspects of health care?

Programs of systematic pediatric guidance may be classified as in-patient (controlled regimen) or out-patient (prescribed regimen). The studies by Blatt and Schapiro (6) and Boyd (7) fall in the former category. Included in the latter category are studies by Bakwin and Bakwin (2), Joslin and Helms (18), Rhoads and others (25), Richdorf (26), and Vickers and Stuart (34).

In the Blatt and Schapiro and the Boyd investigations, head girth records were obtained on 236 physically normal, White infants (3 per cent Negro) living under controlled conditions of housing and diet. The subjects were housed in hospitals at Chicago and Iowa City respectively, and were fed diets "designed to meet good standards of infant nutrition."[8] By combining the data from both investigations, it was possible to secure means at selected ages representing the "controlled intake studies" presently available. Table 13 presents these means and compares them with the composite means for White infants from Table 9.

Table 13 also carries parallel columns of means for "prescribed intake studies," and for studies where there was little

[8] *Within the Blatt and Schapiro series there was experimental variation in the quantities of vitamin B and minerals, within the Boyd series experimental variation in the amount of vitamin D.*

or no attempt to modify the extent to which parents voluntarily availed themselves of the community resources for nutritional and health guidance. The latter column was derived by merging the investigations of Bayley and Davis (5), Gesell and Thompson (12), Meredith (21), and Washburn and Redfield (35); the former represents a colligation of data from Bakwin and Bakwin (2), Richdorf (26), and Vickers and Stuart (34). In both instances the subjects may be characterized as White infants mainly of northwest European ancestry and from homes of average to superior socio-economic status.

TABLE 13

HEAD CIRCUMFERENCE (Centimeters): Means for White infants receiving two types of dietary supervision compared with means obtained without reference to dietary supervision.

Age (mos.)	Controlled Intake Studies		Composite (from Table 9)		Controlled Intake − Composite	Significance Ratio (t)
	Number	Mean	Number	Mean		
3	132	39.2	1239	39.9	- 0.7	5.1*
6	122	41.9	2193	43.0	- 1.1	8.4
12	73	44.9	2166	46.0	- 1.1	6.2
18	45	46.6	1611	47.6	- 1.0	4.4
	Prescribed Intake Studies		Diversity of Intake		Prescribed Intake − Diversity	
(Infants mainly of northwest European ancestry and middle to upper classes)						
3	521	40.1	371	40.2	- 0.1	...
6	508	43.0	561	43.2	- 0.2	...
12	354	46.3	676	46.2	0.1	...
24	206	48.9	471	48.8	0.1	...

*These ratios were calculated using the appropriate composite sigmas from the footnote to Table 10.

The first major finding from Table 13 is that mean head girth is decidedly smaller for infants participating in controlled intake investigations than for the conglomerate of White infants studied. This finding may be reinforced by noting in Tables 3 to 7 that no other head girth data on full-term infants collected since 1920 have yielded values for central tendency as low as those of Blatt and Schapiro (data collected 1931-33) and Boyd (data collected 1930-44). How is the relatively small head girth of these "controlled intake" subjects to be explained? Boyd's measurements were made "over the greatest prominence of the occiput and of the glabella"; Blatt and Schapiro did not specify the anthropometric landmarks employed. Boyd's infants

were "presumably normal," Blatt and Schapiro's were without "abnormalities of the head due to syphilis, rickets, hydrocephalus or microcephalus." For both studies, the subjects were well infants "living under as nearly ideal conditions as institutional life permitted." There remains the probability that factors negatively related to head size operated in the selection of the samples - the probability that infants available for in-patient research tend to be smaller in head girth than infants selected at random.

A second major finding from Table 13 is that, with particular reference to the middle and upper socio-economic groups, mean head girth is not significantly different on infants enrolled in a program of pediatric guidance than on infants less homogeneous for dietary and health care. At no age can the mean from the prescribed intake studies be regarded as dependably larger than that depicting the greater range of intake. The increase in mean over the interval from three months to two years is the same for the prescribed intake studies (8.8 cm.) as for the wide assortment of studies combined in Table 9.

Studies pertaining to the association between rate of growth in head circumference and early inclusion in the dietary of special vitamin and mineral supplements are those of Blatt and Schapiro (6), Joslin and Helms (18), and Rhoads and others (25). Blatt and Schapiro investigated the relationship of head girth in infancy to inclusion in the dietary of a cereal mixture especially enriched with vitamin B and minerals. The subjects were 136 well infants distributed in age over the first two postnatal years and "observed for periods varying from six weeks to one year." For those observed during early infancy, the basic diet included cow's milk with dextrimaltose, orange juice, and cod liver oil. Cereal was added at three months, vegetables and soups at five months, eggs and puddings in the ninth month. Sixty-six infants were fed "the commonly used cereals" and 70 the cereal mixture rich in minerals and vitamin B. No information was afforded on the numbers followed for six weeks only and for longer periods to one year. Head girth averages at eighteen months of age exceeded those at three months by 7.3 cm. for the experimental group and 7.4 cm. for the control group. Over the same age interval, the difference in the composite means from Table 9 is 7.7 cm.

Joslin and Helms' study also dealt with the association between gain in head circumference and "amount of vitamin B complex in the diet." Here, 100 infants were followed "over a period of one year" through a pediatric clinic. The basic diet consisted of milk, water and carbohydrate, with the addition of cereal and vegetables after six months of age. Half the group

was prescribed a special mixture of carbohydrate with vitamin B complex. The average gains in head girth were 9.8 cm. for the experimental series and 9.3 cm. for the control series. In the absence of evidence that the two series were equated for age or head size at the beginning of the study, it is not possible to evaluate their difference in gain. Moreover, since the specific limits of the one-year period(s) are not designated, no fruitful comparisons can be made with findings from other studies. It is improbable that the period covered was the first postnatal year - this follows from Table 9, where the difference between the composite means for White infants at birth and at one year is shown to be 11.7 cm. The figures reported by Joslin and Helms more nearly approximate the rise in the composite trend of 9.7 cm. between the ages of one and thirteen months.

Rhoads and others investigated the influence of supplements of vitamins D, A, and B complex on the head girth of 233 male infants under dietary supervision from an average age of six postnatal weeks until the end of the second year. Four dietary subgroups were formed. All were prescribed a basic diet which included evaporated milk and orange juice from the first examination; banana, cereal, and puréed vegetables and fruits by six months; and egg, meat and potatoes by one year. In addition, one subgroup each was supplied the following daily vitamin supplements: 110 U.S.P. units of D; 110 U.S.P. units of D and 2,250 units of A; 1,500 U.S.P. units of D and 15,000 units of A; 110 U.S.P. units of D, 2,225 units of A, 0.5 mg. of B_1 and 0.2 mg. of B_2. Analyses at ages three months, one year, and two years yielded no statistically significant differences in head circumference between any of the subgroups. For all four subgroups of White males combined, the mean at two years surpassed the mean at three months by 8.9 cm. Over the same period, the increase in composite means for White males without regard to diet (see Table 24) is 8.8 cm.

How may the foregoing studies on "head girth in relation to diet" be summarized? First, it must be recognized that they lie within a somewhat restricted nutritional zone. All of the groups compared probably typify nutritional standards between "mildly inadequate" and "optimum." Within this zone, the over-all finding is that no positive relationship between diet and head circumference has been demonstrated.

Head girth in relation to disease

There is a paucity of head circumference data on groups of infants hospitalized for ill-health, diagnosed as having a specific disease, or appraised as poorly nourished. Bakwin and

Bakwin (3) compared the head girths of 126 infants having "typical facial eczema" with those of 775 infants hospitalized either "as healthy boarders or because of mild respiratory infections." Both samples were composed of White infants of "low income" families. The records on the eczematous infants were plotted in relation to the mean trend for the non-eczematous infants - 60 per cent fell above the trend and 40 per cent below. It was implied that the tendency toward larger head circumference found among the eczematous infants indicated that "constitution is a factor in the etiology of eczema." Unfortunately, Bakwin and Bakwin's materials were not reported in a form which allows them to be quantitatively aligned with materials from other studies.

Chapin (9) and Fleischner (11) each studied head circumference on "hospital patients," many of whom were considered "much below par." Their samples were obtained at New York City - one in 1894 and the other around 1905. Table 14 places combined means at three ages from these studies in juxtaposition with composite means for like ages from Table 9. Also exhibited in Table 14 are averages representing two subdivisions of Fleischner's data. It will be recalled that this investigator classified approximately 40 per cent of his subjects as poorly nourished and 25 per cent as well nourished.

TABLE 14

HEAD CIRCUMFERENCE (Centimeters): Means from infants hospitalized for ill-health compared with means obtained without reference to health history. Subgroups of hospital patients considered poorly nourished and well nourished are also compared.

Age (mos.)	"Hospital patients"		Composite (from Table 9)		Hospitalized - Composite
	Number	Mean	Number	Mean	
3	102	37.9	1239	39.9	- 2.0
6	84	40.4	2193	43.0	- 2.6
9	88	42.5	1791	44.9	- 2.4
	"Poorly nourished"		"Well nourished"		Poorly Nourished - Well Nourished
3	...	36.2	...	40.1	- 3.9
6	...	39.2	...	42.6	- 3.4
9	...	41.2	...	44.4	- 3.2

Findings from Table 14 are:

1. Mean head girth is markedly smaller for the "hospital patients" than for the composite of North American infants. The range of disease conditions and physical defects encompas-

sed by "hospital patients" was not described by either Chapin or Fleischner. Chapin commented that many of his subjects were "much below par," Fleischner mentioned the "probability" that a number of his were born prematurely. Inspection of Tables 3, 4 and 5 will show Chapin's means to be the smallest listed and Fleischner's to rank next.

2. Mean head girth is markedly larger for the hospital patients rated as well nourished than for those rated as poorly nourished. Fleischner made reference to the probability that a "large majority" of the poorly nourished group was "premature." In this connection it is relevant to note that the sample of premature infants studied by Mohr and Bartelme (22) yielded a mean head circumference at age nine months over two centimeters higher than that from the infants Fleischner classed as "poorly nourished."

3. Mean head girth is no larger for Fleischner's "well nourished" class of hospital patients than for the composite of White infants used in deriving Table 9. For example, at age six months the mean on the infants appraised as well nourished is 42.6 cm., while that reproduced from Table 9 is 43.0 cm.

Head girth in relation to prematurity

Data for head circumference on infants born prematurely are available from Mohr and Bartelme (22) and from Talbot (31). In Talbot's study, "the criteria used in establishing prematurity were weight, stature, and general considerations, such as facies, texture of the skin, undeveloped nails, cry, unstable temperature and history of expected birth"; Mohr and Bartelme's criterion was "birth weight less than 2,500 gm." Talbot's subjects were considered "from four to ten weeks premature"; Mohr and Bartelme's had a mean gestation period of approximately thirty-four weeks. Talbot used statutory age; Mohr and Bartelme corrected statutory age for the estimated amount of prematurity. Talbot's data afford a mean one month after birth; Mohr and Bartelme's data supply means at older ages. Table 15 aligns both studies with comparable materials on full-term infants. (See Table 15, p. 45.)

It will be seen that:

1. At the end of the first postnatal month, the mean head girth of the premature infants studied by Talbot is 30.9 cm. (12.2 in.) - roughly equivalent to the mean head girth for normal fetuses one month prior to birth. The mean from Table 9 for North American full-term infants age one month is higher by 5.7 cm. (2.2 in.).

2. At the middle of the second postnatal year, the mean head girth of the premature infants followed by Mohr and Bartelme

TABLE 15

HEAD CIRCUMFERENCE (Centimeters): Comparison of central tendency values for premature and full-term infants.

Age	Infants Born Prematurely		Full-term Composite (from Table 9)		Prematurely Born - Full-term
	Number	Mean	Number	Mean	
1	13	30.9	195	36.6	- 5.7
3	6	37.3*	1239	39.9	- 2.6
6	10	42.0	2193	43.0	- 1.0
9	15	44.2	1791	44.9	- 0.7
12	16	45.9	2166	46.0	- 0.1
18	48	47.6	1611	47.6	0.0

*The means for premature infants at ages three to eighteen months represent statutory age minus the estimated amount of prematurity.

is practically equal to that for full-term infants. (Adjustment of the premature mean at eighteen months to statutory age would only reduce it from 47.9 cm. to 47.6 cm.). It will be recalled that Mohr and Bartelme's subjects were the recipients of excellent postnatal care.

The generalization which accrues is that the mean trends for head circumference on infants born "prematurely" and "at term" gradually converge during infancy. In relation to the trend for full-term infants, the trend for premature infants ascends from a lower level at birth to become almost superimposed by the middle of the second year.

Head girth in relation to birth molding and birth order

Anthropometrically comparable data for head circumference at birth are available from Calkins (8) and Tiber (32). Tiber's sample was drawn without reference to birth molding, while Calkin's sample represents heads largely free from molding, i. e., births by cesarean section or breech extraction. Both investigators measured the maximum perimeter of the head through the glabella, using "very slight uniform pressure." Their subjects were all full-term, viable infants, and the means obtained were, for Calkins, 35.2 cm. and, for Tiber, 33.5 cm. (see Table 1). Calkins' mean (N = 27) is 1.7 cm. higher than Tiber's, and 0.9 cm. higher than the composite mean from Table 9. The significance ratios from both comparisons allow the inference that full-term neonates have a smaller head circumference following the typical birth process than following cesarean section.

Bakwin and Bakwin (1) compared means for head girth derived from measurement of 812 first-born infants and 841 infants of later birth orders. Both series of data were accumulated by the same anthropometrist, utilizing White neonates delivered

at four New York City hospitals. The "later-born" sample gave a mean of 34.5 cm. A mean lower by 0.3 cm. was secured from the "first-born" records.

One other reference treating head circumference in relation to order of birth is that by Williams (36). Three decades prior to publication of the Bakwin and Bakwin study, Williams reported that mean head girth was "somewhat larger" for "children of multiparae than those of primiparae." While no quantitative material on different parity classes was supplied, the notation is consistent with Bakwin and Bakwin's finding of a slightly smaller mean girth for first-born neonates than for the aggregate of neonates of other birth orders.

Sex differences in head girth

Answers were sought to the following questions: What is the average head circumference of males and females at selected infancy ages? Is the head circumference of the typical newborn male larger than that of the female? Does the difference between the sexes increase or decrease during infancy? How widely dispersed are the measurements of head girth for male and female infants at different ages? Does variability change appreciably over the first two postnatal years? Do the records of head girth for one sex show greater scatter than those for the other?

The method employed was that of first compiling Tables 16 to 23. These tables bring together all of the available central tendency and variability values for full-term male and female infants at each of eleven ages - the same eleven ages as were used in constructing Tables 1 to 8. The tables are self-explanatory.

The next step consisted of utilizing Tables 16 to 23 to derive an over-all representation at successive ages of the central tendency and variability materials on White infants of each sex. Except for rejections on either of two counts (to exclude non-White data or to avoid duplicate use of White data), all of the figures assembled for a given age and sex were employed. The specific rejections were as follows: From Table 16, Stuart (1934), Ito (1936) and Holt and Howland (1919); from Table 18, Stuart (1934) and the Negro data of Rhoads and others (1945); from Tables 19 and 22, Stuart (1934) and Holt (1897); from Table 20, Stuart (1934); from Table 21, Stuart (1934), the Negro data of Rhoads and others (1945) and Holt (1897); from Table 23, Stuart (1934), the Negro data of Rhoads and others (1945), Ramsay (1853) and Holt (1897).

TABLE 16

HEAD CIRCUMFERENCE AT BIRTH (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from thirteen North American studies. See Table 1 for a list of the leading characteristics of each sample.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stebbins (1933)	50	34.6	1.0	2.9	32.6	33.3	34.0	35.1	35.9	37.3
Stuart (1934)	50	35.4	1.3	3.7	32.4	33.7	34.5	36.0	37.3	38.0
Vickers and Stuart (1943)	99	35.3	1.2	3.4	32.6	33.5	34.4	36.2	37.0	38.0
Montague and Hollingworth (1914)	1000	34.2	1.7	4.9	29.0		33.1	35.2		41.5
Taylor (1919)	125	34.7	1.1	3.2	29.8		34.2	35.3		37.8
Ito (1936)	94	34.0	1.1	3.3	31.6					37.5
Bayley and Davis (1935)	28	35.5	1.1	3.2	33.3					39.0
Calkins (1922)	18	35.2			33.0					37.5
Washburn and Redfield (1945)	9	34.7			33.0					36.6
Tiber (1930)	106	33.8					32.7	34.8		
Bakwin and Bakwin (1934)	818	34.6	1.3	3.7						
Holt (1897)	231	35.5								
Holt and Howland (1919)	...	35.3								
Females										
Stebbins (1933)	50	33.6	1.0	2.8	31.4	32.4	32.9	34.4	34.9	35.2
Stuart (1934)	63	34.4	1.4	4.1	31.2	33.1	33.7	35.5	36.0	37.0
Vickers and Stuart (1943)	110	34.7	1.0	2.9	31.0	33.4	33.9	35.4	36.0	37.2
Montague and Hollingworth (1914)	1000	33.6	1.6	4.6	28.0		32.6	34.7		39.5
Taylor (1919)	125	34.1	1.2	3.6	30.6		33.4	34.8		36.8
Ito (1936)	108	33.8	1.2	3.7	28.0					37.0
Bayley and Davis (1935)	25	34.5	1.4	4.0	31.3					37.0
Calkins (1922)	9	35.1			33.4					38.5
Washburn and Redfield (1945)	12	34.0			32.4					35.9
Tiber (1930)	102	33.1					32.3	34.0		
Bakwin and Bakwin (1934)	835	34.0	1.3	3.7						
Holt (1897)	215	34.5								
Holt and Howland (1919)	...	34.3								

TABLE 17

HEAD CIRCUMFERENCE AT AGES ONE WEEK TO TWO MONTHS (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from thirteen North American studies.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
ONE WEEK: Males										
Richdorf (1925)	20	35.0	1.1	3.2	32.8		34.0	36.0		37.5
Tiber (1930)	106	34.4					33.4	35.3		
Stebbins (1933)	50	35.0	1.0	2.9	33.1	33.5	34.4	35.5	36.4	37.4
Females										
Richdorf (1925)	21	34.4	0.8	2.3	32.5		34.0	35.0		35.5
Tiber (1930)	102	33.6					32.8	34.5		
Swanson (1926)	30	33.9								
Stebbins (1933)	50	34.0	1.0	2.9	31.8	32.8	33.2	34.7	35.2	35.6
TWO WEEKS: Males										
Stuart (1934)	33	36.3	1.2	3.3	33.9	35.0	35.5	37.0	37.9	38.2
Bakwin and Bakwin (1936)	c.90	35.4	1.5	4.1						
Females										
Stuart (1934)	50	35.5	1.2	3.4	32.8	33.7	34.6	36.5	37.2	38.0
Bakwin and Bakwin (1936)	c.100	34.8	1.4	4.0						
ONE MONTH: Males										
Washburn and Redfield (1945)	20	37.2	1.3	3.6	34.6		36.5	37.9		39.3
Bayley and Davis (1935)	24	38.6	1.2	3.1						
Boyd (1945)	55	36.0	1.4	3.9						
Grover (1915)	4	36.7								
Iowa Child Welfare Research Station (1931)	14	37.5								
Females										
Washburn and Redfield (1945)	20	36.4	1.0	2.7	34.0		36.0	36.9		38.3
Bayley and Davis (1935)	26	37.1	1.2	3.3						
Boyd (1945)	16	35.0	0.8	2.3						
Grover (1915)	3	35.6								
Iowa Child Welfare Research Station (1931)	13	35.1								
TWO MONTHS: Males										
Meredith (1944)	35	38.9	1.1	2.8	36.3		38.2	39.7		41.0
Washburn and Redfield (1945)	19	38.8	1.2	3.0	36.2		38.2	39.6		40.8
Gesell and Thompson (1938)	14	39.0	1.2	3.2	36.2					40.6
Iowa Child Welfare Research Station (1931)	22	39.3	1.4	3.5						
Bayley and Davis (1935)	31	40.1	1.1	2.8						
Boyd (1945)	65	38.4	1.4	3.8						
Females										
Meredith (1944)	25	38.2	1.3	3.5	35.6		37.3	39.0		40.5
Washburn and Redfield (1945)	22	37.8	0.8	2.0	36.0		37.3	38.4		39.2
Gesell and Thompson (1938)	12	38.1	1.0	2.6	36.5					39.5
Bayley and Davis (1935)	27	38.8	1.2	3.1						
Boyd (1945)	17	37.2	1.3	3.4						
Iowa Child Welfare Research Station (1931)	6	37.6								

TABLE 18

HEAD CIRCUMFERENCE AT AGE THREE MONTHS (Centimeters): Central tendency and variability values, for full-term male and female infants. The values are drawn from fourteen North American studies.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stuart (1934)	50	41.0	1.3	3.2	38.6	39.2	40.1	41.8	42.7	44.0
Vickers and Stuart (1943)	125	40.8	1.2	2.9	38.2	39.2	40.0	41.5	42.1	44.5
Meredith (1944)	112	40.6	1.1	2.6	37.8	39.2	40.0	41.2	41.8	43.6
Richdorf (1925)	50	40.6	1.5	3.8	37.0		39.4	41.6		44.0
Washburn and Redfield (1945)	35	40.4	1.2	3.0	38.3		39.7	41.3		42.6
Gesell and Thompson (1938)	12	40.8	0.9	2.3	39.1					42.3
Baldwin, Fillmore and Hadley (1930)	16	41.4	2.3	5.6						
Iowa Child Welfare Research Station (1931)	26	40.6	1.4	3.4						
Bayley and Davis (1935)	31	41.5	1.2	2.9						
Bakwin and Bakwin (1936)	c.85	40.2	1.3	3.3						
Boyd (1945)	71	39.5	1.4	3.5						
Rhoads and others (1945):										
White	134	39.9	1.3	3.2						
Negro	99	39.8	1.3	3.3						
Grover (1915)	7	38.6								
Talbot (1924)	c.20	39.4								
Females										
Stuart (1934)	69	40.2	1.2	3.0	38.2	38.5	39.1	41.1	41.8	42.6
Vickers and Stuart (1943)	121	40.0	1.2	3.0	37.0	38.5	39.2	40.8	41.7	42.8
Meredith (1944)	93	39.4	1.2	3.1	36.3	37.9	38.7	40.2	41.0	42.1
Richdorf (1925)	50	39.1	1.1	2.8	37.0		38.4	39.9		41.3
Washburn and Redfield (1945)	40	39.4	1.0	2.4	37.1		38.7	40.0		41.2
Gesell and Thompson (1938)	13	39.4	1.1	2.7	37.5					40.9
Baldwin, Fillmore and Hadley (1930)	12	39.4	2.1	5.3						
Bayley and Davis (1935)	29	40.2	1.1	2.6						
Bakwin and Bakwin (1936)	c.90	39.2	1.3	3.4						
Boyd (1945)	16	38.5	1.2	3.1						
Grover (1915)	9	37.7								
Talbot (1924)	c.15	38.4								
Iowa Child Welfare Research Station (1931)	8	39.3								

TABLE 19

HEAD CIRCUMFERENCE AT AGE SIX MONTHS (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from eighteen North American studies.

Investigator	N	Mean	S.D.	V	Mini-mum	Percentiles 10	25	75	90	Maxi-mum
Males										
Stuart (1934)	45	44.2*	1.1	2.4	41.8	42.5	43.3	45.0	45.7	46.0
Vickers and Stuart (1943)	117	44.0	1.0	2.3	41.8	42.7	43.3	44.8	45.4	46.3
Meredith (1944)	205	43.7	1.3	2.9	40.4	42.2	42.9	44.5	45.4	47.2
Richdorf (1925)	50	43.5	1.0	2.2	41.5		42.9	44.2		45.9
Washburn and Redfield (1945)	42	43.4	1.2	2.7	41.0		42.6	44.2		46.3
Gesell and Thompson (1938)	15	43.8	0.9	2.0	42.4					45.4
Iowa Child Welfare Research Station (1931)	40	44.3	1.6	3.7						
Bayley and Davis (1935)	30	44.9	1.2	2.6						
Bakwin and Bakwin (1936)	c.75	43.2	1.2	2.7						
Boyd (1945)	64	42.4	1.2	2.7						
Holt (1897)	...	43.5								
Grover (1915)	14	42.5								
Crum (1916)	259	44.1								
Holt and Howland (1919)	c.100	43.2								
Talbot (1924)	25	42.6								
Baldwin, Fillmore and Hadley (1930)	23	44.1								
Mohr and Bartelme (1934)	5	42.0								
Females										
Stuart (1934)	57	43.1	1.3	3.0	41.0	41.4	42.1	43.9	44.8	46.2
Vickers and Stuart (1943)	131	42.9	1.2	2.8	40.2	41.4	42.0	43.6	44.5	46.8
Meredith (1944)	180	42.4	1.3	3.0	38.8	40.8	41.6	43.2	44.0	45.2
Richdorf (1925)	50	42.3	1.3	3.2	39.2		41.5	42.9		44.8
Washburn and Redfield (1945)	41	42.4	1.0	2.4	39.9		41.7	43.9		44.4
Gesell and Thompson (1938)	19	42.2	1.0	2.4	40.4					44.8
Iowa Child Welfare Research Station (1931)	19	42.7	1.6	3.8						
Bayley and Davis (1935)	28	43.3	1.2	2.7						
Bakwin and Bakwin (1936)	c.85	42.1	1.2	2.8						
Boyd (1945)	13	41.2	0.8	1.9						
Holt (1897)	...	42.2								
Grover (1915)	11	41.5								
Crum (1916)	176	42.9								
Holt and Howland (1919)	c.100	42.3								
Talbot (1924)	25	42.3								
Swanson (1926)	30	40.8								
Baldwin, Fillmore and Hadley (1930)	19	42.2								

*The mean is reported as 44.9, the median as 44.2. There is apparently a typographical error in the case of the mean.

TABLE 20

HEAD CIRCUMFERENCE AT AGE NINE MONTHS (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from thirteen North American studies. See Table 5 for a list of the leading characteristics of each sample.

Investigator	N	Mean	S.D.	V	Percentiles					
					Minimum	10	25	75	90	Maximum
Males										
Stuart (1934)	41	46.0	1.1	2.4	43.6	44.4	45.1	46.7	47.4	48.4
Vickers and Stuart (1943)	115	45.8	1.0	2.2	43.1	44.5	45.1	46.5	47.1	49.0
Meredith (1944)	249	45.6	1.2	2.7	42.6	44.1	44.7	46.4	47.2	49.2
Richdorf (1925)	49	45.4	1.2	2.6	43.0		44.6	46.2		49.0
Washburn and Redfield (1945)	38	45.3	1.0	2.2	43.0		44.7	46.1		47.1
Gesell and Thompson (1938)	17	45.9	1.2	2.5	43.9					48.6
Baldwin, Fillmore and Hadley (1930)	31	46.0	1.6	3.5						
Iowa Child Welfare Research Station (1931)	32	45.2	1.3	2.8						
Bayley and Davis (1935)	27	47.0	1.2	2.5						
Bakwin and Bakwin (1936)	c.70	45.2	1.3	2.9						
Boyd (1945)	24	44.3	1.1	2.5						
Crum (1916)	211	45.8								
Females										
Stuart (1934)	54	44.8	1.4	3.1	42.3	42.9	43.8	45.8	46.8	47.9
Vickers and Stuart (1943)	121	44.7	1.2	2.7	42.1	43.2	43.8	45.4	46.3	47.9
Meredith (1944)	226	44.2	1.2	2.7	41.1	42.8	43.3	45.0	45.8	47.2
Richdorf (1925)	49	44.7	1.4	3.1	42.1		43.9	45.5		48.5
Washburn and Redfield (1945)	39	44.2	1.2	2.7	41.3		43.5	45.1		46.5
Gesell and Thompson (1938)	17	43.9	1.2	2.8	42.2					46.5
Baldwin, Fillmore and Hadley (1930)	26	44.2	1.9	4.3						
Iowa Child Welfare Research Station (1931)	24	44.5	1.5	3.3						
Bayley and Davis (1935)	29	45.4	1.3	2.9						
Bakwin and Bakwin (1936)	c.70	44.1	1.2	2.7						
Crum (1916)	183	44.7								
Mohr and Bartelme (1934)	4	44.3								
Boyd (1945)	4	42.7								

TABLE 21

HEAD CIRCUMFERENCE AT AGE ONE YEAR (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from sixteen North American studies.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stuart (1934)	37	47.2	1.0	2.1	45.1	45.6	46.5	47.9	48.6	49.3
Vickers and Stuart (1943)	113	47.1	1.1	2.3	43.4	45.5	46.5	47.8	48.4	49.3
Meredith (1944)	258	46.8	1.3	2.8	43.6	45.1	45.9	47.6	48.5	50.3
Washburn and Redfield (1945)	40	46.6	1.0	2.2	44.2		46.0	47.3		49.2
Gesell and Thompson (1938)	19	47.3	0.9	1.8	45.4					48.5
Baldwin, Fillmore and Hadley (1930)	33	46.9	1.3	2.8						
Iowa Child Welfare Research Station (1931)	26	47.1	1.5	3.2						
Bayley and Davis (1935)	28	48.5	1.3	2.7						
Bakwin and Bakwin (1936)	c.60	46.5	1.3	2.8						
Boyd (1945)	24	45.5	1.2	2.6						
Rhoads and others (1945):										
White	134	46.4	1.3	2.7						
Negro	99	46.2	1.5	3.2						
Holt (1897)	...	45.9								
Grover (1915)	11	44.6								
Crum (1916)	284	47.1								
Holt and Howland (1919)	c.100	45.7								
Talbot (1924)	15	46.8								
Females										
Stuart (1934)	48	46.0	1.4	3.0	43.6	44.1	44.9	46.9	47.9	49.1
Vickers and Stuart (1943)	121	45.9	1.3	2.8	43.2	44.3	45.0	46.7	47.7	49.1
Meredith (1944)	238	45.4	1.3	2.8	42.3	43.8	44.4	46.3	47.2	48.5
Washburn and Redfield (1945)	42	45.5	1.2	2.7	42.4		44.6	46.4		48.0
Gesell and Thompson (1938)	24	45.0	1.1	2.4	43.3					47.9
Baldwin, Fillmore and Hadley (1930)	23	45.4	2.1	4.7						
Iowa Child Welfare Research Station (1931)	25	45.5	1.2	2.6						
Bayley and Davis (1935)	27	46.8	1.4	2.9						
Bakwin and Bakwin (1936)	c.60	45.5	1.1	2.4						
Holt (1897)	...	44.6								
Grover (1915)	12	44.9								
Crum (1916)	228	45.9								
Holt and Howland (1919)	c.100	44.5								
Talbot (1924)	25	46.0								
Boyd (1945)	4	44.9								

TABLE 22

HEAD CIRCUMFERENCE AT AGE EIGHTEEN MONTHS (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from fourteen North American studies.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stuart (1934)	34	49.1	1.2	2.4	47.0	47.4	48.1	49.8	50.9	51.2
Vickers and Stuart (1943)	108	48.8	1.1	2.3	46.2	47.3	48.0	49.4	50.1	51.8
Meredith (1944)	204	48.3	1.2	2.5	45.8	46.7	47.5	49.1	49.9	51.7
Washburn and Redfield (1945)	41	48.3	0.8	1.7	45.9		47.9	48.9		50.0
Baldwin, Fillmore and Hadley (1930)	32	48.4	1.3	2.8						
Iowa Child Welfare Research Station (1931)	23	48.8	1.3	2.6						
Bayley and Davis (1935)	22	49.8	1.3	2.6						
Holt (1897)	...	47.1								
Grover (1915)	14	46.9								
Crum (1916)	181	48.4								
Holt and Howland (1919)	c.100	47.5								
Talbot (1924)	15	48.5								
Mohr and Bartelme (1934)	4	48.3								
Females										
Stuart (1934)	44	47.4	1.4	3.0	44.8	45.7	46.4	48.3	49.5	50.1
Vickers and Stuart (1943)	107	47.4	1.2	2.5	43.9	45.8	46.5	48.3	49.1	50.2
Meredith (1944)	204	47.0	1.2	2.6	43.9	45.3	46.0	47.8	48.6	49.6
Washburn and Redfield (1945)	39	47.0	1.4	3.1	43.4		46.1	48.0		49.8
Baldwin, Fillmore and Hadley (1930)	21	46.8	1.8	3.8						
Bayley and Davis (1935)	23	48.0	1.3	2.7						
Holt (1897)	...	45.9								
Grover (1915)	7	45.6								
Crum (1916)	178	47.1								
Holt and Howland (1919)	c.100	45.7								
Talbot (1924)	15	47.8								
Swanson (1926)	30	46.0								
Iowa Child Welfare Research Station (1931)	13	47.4								
Mohr and Bartelme (1934)	8	46.2								

TABLE 23

HEAD CIRCUMFERENCE AT AGE TWO YEARS (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from fifteen North American studies.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stuart (1934)	26	50.0	1.3	2.6	47.8	48.2	49.1	50.9	51.7	52.0
Vickers and Stuart (1943)	102	49.6	1.2	2.4	46.0	48.1	48.7	50.4	51.2	52.0
Meredith (1944)	186	49.3	1.2	2.4	46.7	47.9	48.4	50.2	50.9	52.3
Washburn and Redfield (1945)	40	49.3	0.9	1.8	47.6		48.7	49.9		50.9
Baldwin, Fillmore and Hadley (1930)	25	49.4	1.3	2.7						
Iowa Child Welfare Research Station (1931)	17	50.0	1.1	2.3						
Bayley and Davis (1935)	24	50.7	1.4	2.8						
Rhoads and others (1945):										
White	134	48.8	1.3	2.7						
Negro	99	48.5	1.5	3.1						
Ramsay (1853)	4	48.7								
Holt (1897)	...	48.2								
Grover (1915)	14	48.2								
Crum (1916)	201	49.3								
Holt and Howland (1919)	c.100	48.7								
Talbot (1924)	10	49.2								
Mohr and Bartelme (1934)	3	50.3								
Females										
Stuart (1934)	30	48.2	1.3	2.7	46.2	46.5	47.2	49.2	50.0	50.5
Vickers and Stuart (1943)	104	48.2	1.4	2.9	45.5	46.3	47.1	49.1	50.2	51.4
Meredith (1944)	165	48.0	1.2	2.5	45.0	46.4	47.1	48.9	49.6	51.0
Washburn and Redfield (1945)	38	47.9	1.4	3.0	44.2		47.0	49.1		50.5
Baldwin, Fillmore and Hadley (1930)	20	47.9	1.1	2.3						
Iowa Child Welfare Research Station (1931)	23	48.2	1.3	2.7						
Bayley and Davis (1935)	18	49.0	1.2	2.4						
Holt (1897)	...	47.2								
Grover (1915)	9	48.3								
Crum (1916)	160	48.2								
Holt and Howland (1919)	c.100	47.5								
Talbot (1924)	10	48.8								

The synthesis derived is presented in Table 24. The upper portion of this table affords composite means,[9] standard deviations,[10] and coefficients of variation[11] for full-term White infants of each sex. In the lower portion of the table are additional columns portraying the composite range, the typical range, the typical distance between the tenth and ninetieth percentiles, and the typical interquartile distance (seventy-fifth percentile minus twenty-fifth percentile). There is the statistical distinction between the "composite" and the "typical" values. To illustrate. The composite standard deviation for males at birth is the standard deviation of one distribution formed by "combining" the distributions from several studies: The typical interquartile distance for males at birth is the mean obtained by "averaging" the interquartile values from several studies. Similarly, the "composite range" for newborn males is the difference between the minimum and maximum records reported, while the "typical range" is the mean of the range values from different studies.

Findings from Table 24 (i. e., sex differences for North American White infants born at term) are:

1. Male infants exceed female infants in mean head girth at all ages from birth to two years. The difference increases over the period from birth to six months, and remains practically constant during the succeeding eighteen months. In magnitude, the difference approximates one-fourth inch (0.6 cm.) at birth and one-half inch (1.2 cm.) between six months and the end of the second year.

2. At birth, mean head girth is 34.5 cm. (13.6 in.) for male

[9] *For an algebraic statement of the formula used, see footnote 3.*

[10] *The formula for calculating a composite standard deviation is*

$$S.D._c = \sqrt{\frac{N_1(S.D._1{}^2 + d_1{}^2) + N_2(S.D._2{}^2 + d_2{}^2) + \ldots + N_x(S.D._x{}^2 + d_x{}^2)}{N_1 + N_2 + \ldots + N_x}}$$

in which S.D. symbolizes standard deviation, N symbolizes number of measures, d represents the deviation of the mean of a component sample from the mean for the composite sample, subscript c designates the composite sample, and the numerical subscripts designate component samples.

[11] *Computed by the usual formula (V = S.D. x 100/Mean), using composite values in the numerator and the denominator.*

TABLE 24

HEAD CIRCUMFERENCE (Centimeters): Central tendency and variability values for White infants of each sex studied in North America during the period 1890-1945. (See text for a description of the basic materials and the methods of integration.)

Age (mos.)	Composite Means				Composite Measures of Variability					
	MALES		FEMALES		MALES			FEMALES		
	N	Mean	N	Mean	N	S.D.	V	N	S.D.	V
Birth	2484	34.5	2483	33.9	2120	1.5	4.3	2145	1.5	4.4
1	117	36.9	78	36.1	99	1.6	4.3	62	1.4	3.9
2	186	39.0	109	38.1	186	1.4	3.6	103	1.3	3.4
3	724	40.4	496	39.4	697	1.4	3.4	464	1.3	3.3
6	1064	43.7	927	42.5	638	1.3	3.0	566	1.3	3.1
9	863	45.6	792	44.5	652	1.3	2.9	601	1.3	3.0
12	1145	46.7	929	45.5	735	1.3	2.8	560	1.4	3.0
18	744	48.3	745	46.9	430	1.2	2.6	394	1.3	2.8
24	856	49.2	647	48.0	528	1.3	2.6	368	1.3	2.7

	"Typical" Measures of Variability						Composite Range	
	75th Percentile - 25th Percentile		90th Percentile - 10th Percentile		Maximum - Minimum		Maximum - Minimum	
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES
Birth	1.6	1.6	3.0	2.6	6.3	6,0	12.5	11.5
3	1.6	1.5	2.8	3.1	5.3	4.7	7.5	6.5
6	1.5	1.5	3.0	3.1	4.8	5.5	6.8	8.0
9	1.5	1.6	2.9	3.0	5.5	5.6	6.6	7.4
12	1.4	1.8	3.2	3.4	5.2	5.6	6.9	6.8
18	1.3	1.8	3.0	3.3	5.2	6.1	6.0	6.8
24	1.6	2.0	3.1	3.5	5.0	6.0	6.3	7.2

infants and 33.9 cm. (13.3 in.) for female infants. Expressed in relation to these birth values, the means at two years are higher by 14.7 cm. (5.8 in.), or 42.6 per cent, for males and 14.1 cm. (5.6 in.), or 41.6 per cent, for females. The smaller increases for females reflect the divergence of the sexes during the first six months. The means at six months surpass those at birth by 9.2 cm. (26.7 per cent) and 8.6 cm. (25.4 per cent) on males and females respectively: In contrast, the means at two years exceed those at six months by 5.5 cm. (12.6 per cent) on males and 5.5 cm. (12.9 per cent) on females.

3. At all ages between birth and two years, the composite standard deviations for male and female infants are similar. Identical values on both sexes are shown at birth, six months, nine months, and two years. Of the twelve standard deviations representing ages above two months, all except three - two on males and one on females - have the same magnitude (1.3 cm.). The larger values at birth (1.5 cm.) accrue primarily from inclusion of the Montague and Hollingworth study (see Table 16). It is the writer's view that the standard deviations from this

study are probably spuriously high due to the unreliability of the measurements.[12]

4. Over the first two postnatal years, there is a continuous decrease in the relative variability of head girth. Inspection of the "V" columns in Table 24 shows this finding to hold for both sexes. On the assumption that the "true" standard deviations are 1.3 cm. at birth and at all later ages to two years, the coefficients of variation decrease from a birth value of 3.8 per cent for each sex to the obtained values at two years of 2.6 per cent and 2.7 per cent for males and females respectively.

5. For each sex at birth, the typical interquartile distance is 1.6 cm. (0.6 in.). This figure may be taken as characteristic of the entire series of values for both sexes at all ages - the fluctuations are between 0.3 cm. below to 0.4 cm. above. An alternative estimate of the interquartile distance may be derived via the standard deviation. On the assumption that the head girth is normally distributed, the middle fifty per cent of the measurements lie clustered within a zone equal to 1.35 S. D. Taking the S. D. at 1.3 cm., the estimated interquartile distance is 1.8 cm. (0.7 in.).

Generalizing, it appears that for male or female infants of any age between birth and two years the zone circumscribing the central one-half of the head girth distribution extends from one-third inch below the mean to one-third inch above the mean.

6. The typical distance between the tenth and ninetieth percentiles may be considered to approximate 3.1 cm. (1.2 in.). Values at specific ages vary from 2.6 cm. to 3.5 cm., with 3.0 cm. and 3.1 cm. predominating. The distance between the tenth and ninetieth percentiles of a normal probability distribution having a standard deviation of 1.3 cm. is 3.3 cm. (1.3 in.). It follows that at any age during infancy about 10 per cent of male head girths lie 1.6 cm. or more above the male mean and 10 per cent of female head girths 1.6 cm. or more above the female mean. Correspondingly, there are around one-tenth of the infants of each sex with head girths no less than 1.6 cm. - two-thirds inch - below the mean for their age and sex.

7. Over the age period from three months to two years, the values for the typical range fluctuate around 5.4 cm. (2.1 in.) and those for the composite range around 6.9 cm. (2.7 in.). The

[12] *In this connection, compare the investigations of Montague and Hollingworth (23) and Bakwin and Bakwin (1). The latter was based on records made by a trained anthropometrist, the former on routine hospital records; the latter obtained standard deviations of 1.3 cm. on each sex, the former of 1.7 cm. on males and 1.6 on females; both used large, heterogeneous samples. See Also Reference 20, p. 46.*

values at birth register the exceptionally wide dispersion of the Montague and Hollingworth data (see Table 16) and are regarded as spuriously high. The question arises: Why is the "composite range" greater than the "typical range"? The difference is due, at least in part, to the fact that the composite range is obtained from a larger sample of infants than is any value used in deriving the typical range. It may also be due in part to the composite range encompassing variations in the anthropometric technique with which different portions of the pooled data were secured.

Specific for any infancy age and for nonpathologic White infants of either sex, a working approximation of the "true" range of the head girth distribution may be taken as 6.4 cm. - as extending from a minimum one and one-fourth inches below the mean to a maximum one and one-fourth inches above the mean.

SUMMARY

This paper constitutes Part I of a bipartite study dealing with head circumference during the first two years of postnatal life. It presents a review and synthesis of North American research to date on groups of infants. Its companion paper will colligate the studies made in North America pertaining to the growth of individuals.

Source materials are drawn from thirty-five investigations - twenty-nine published over the years 1853-1945 and six not previously reported in published form. These materials are integrated with reference to the information they afford on ten problems. That is, intercomparisons are made and generalizations derived on head girth in relation to age, sex, lineage, socio-economic status, secular period, diet, disease, prematurity, birth molding, and birth order.

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FATHER-FANTASIES AND FATHER-TYPING IN FATHER-SEPARATED CHILDREN

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The average American father differs considerably from the classical stereotype of a punishment-threatening, tyrant-giant as depicted in European psychoanalytic theory. Still the local U. S. culture is largely patriarchal and paternal opinions are still decisive in the settling of most major family issues. Although the frequently absent father may relegate to the more often present mother the majority of actual punishment executions, and coming home from work, he may be "seldom in a mood to institute disciplinary measures" (13, p. 259), his children (above the age of three and one-half years) are, nevertheless, accurately aware of the preferential power position that the father has in the family.[2]

The psychological nature of a child's relationship to his father is, therefore, of great consequence to the child's present security and later outlook. It is not surprising that complications in this relationship are found in the history of many individuals with adjustment difficulties and that clinical studies of young adults have shown that respect and affection for the father is more characteristic for satisfactory home adjustment than the presence of sentiments of respect and affection for the mother (13).

These impressions gained in clinical practice warrant our research interests in theories and facts concerning father-child relationships.

[1]*The author gratefully acknowledges the assistance he has received in the collection of the data from Gloria Bremer, Elizabeth Wilson, Christine Hillman, and Dr. Robert H. Miller, then graduate students at the Psychological Laboratory of Western Reserve University. The study was partially financed by a research grant made available by Western Reserve University through the kind efforts of Drs. Calvin Hall and Jay Otis.*

[2]*This inference is based on observations made by the author during experiments with preschool children whose play fantasies projected distinctly different emotional reactions to teacher-doll stimulations, depending on the power status that the dolls were given, e.g., assistant teacher, regular, and head teacher.*

The kind of emotional experiences that a son or daughter has within the dynamics of the father-child relationship are given much emphasis in practical mental hygiene (6), and in systematic clinical theories (7). Nevertheless, non-speculative, empirical studies of this relationship have been primarily sociological in nature, relating, for example, the intelligence or attitude test scores of children to the occupational, educational or political status of their fathers (cf. 9).

The present research trend seems to be away from such "ecological" studies (11) as more analytical approaches to the parent-child relationship become popular. Several investigators have attempted to investigate the emotional aspects of this relationship (e.g., 13). However, most of these concentrate on maternal influences (10, 21), or the father and mother are considered as one "parental unit" (2). Much useful information concerning the father has come incidentally out of these studies, but more specific investigations of the intimate, emotional aspects of father-child contact are needed. The present paper reports a research effort in this direction.

Methodology

Subjects

The conditions of war, generally so destructive to systematic research, provided in this case an opportunity for an investigation of the emotional reactions of children to prolonged separation from the father. The enlistment of mature men with families made it possible to locate in Cleveland, Ohio an experimental group of twenty normally adjusted school children, equally divided as to sex, ages six to ten, of average intelligence, and lower middle-class, urban background, whose fathers had been with the Armed Forces abroad from one to three years, and who were still away at the time of the investigation in the Spring of 1945.

A control group of children matched for age, sex, intelligence, school and home background, was also available. The fathers of the control children were deferred from military service and were living with their families. School and home background and overt manifestations of the parent-child relationship were ascertained by intensive interviews of mothers and teachers. These interviews followed the methodology of the Fels Research Group (2, 3, 4).

The Doll Play Technique

The children's emotional reactions to separation from the father were studied by means of a standardized projective doll

play technique which was developed by the author from recent experiments conducted by Sears and his associates at Iowa (1, 14, 15, 16).

The doll play experiments took place in a special room in each of the two elementary schools attended by the subjects.[3]

Each child subject was introduced to the experimenter by the teacher. On three occasions, separated by two to four days, the experimenter took the child from the classroom to the experimental room for a twenty-minute play session. The entire experimental routine, including the experimenter-child relationship before, during and after the three play sessions, was standardized according to a detailed Manual of Instructions. This manual was prepared by the writer in cooperation with Gloria Bremer, who acted as co-experimenter. The essential features of this procedure are summarized below.

Play Materials

The child was presented with a semi-realistic roofless doll house having the dimensions of 22" x 28". This doll house simulated in stream-lined form a five-room, middle-class family home. There was a living room, dining room, kitchen, bathroom, two bedrooms, a hall and a large closet. Most of the stream-lined furniture was glued to the floor to inhibit manipulative construction play and to encourage play with the dolls proper, thus stimulating social fantasies.

Four dolls, a father, a mother, and two children, a boy and a girl, were available to the child. All subjects were given the same family constellation. The parent dolls were 5" and the child dolls 3" tall. The dolls had a realistic appearance and could easily be made to assume any desired posture.

Initial Instigation of Fantasy

After a brief explanation of the physical facilities of the doll house, the experimenter invited the child to make up a story or play. The experimenter made it clear that it could be any kind of a story; that the child could make the four "people in this home" act in any way he wanted them to.

After the experimenter gave these instructions, he began the recording of the fantasy responses. After twenty minutes the recording was discontinued and the play session terminated.

All of the children in this study entered the task with interest, and while activating the dolls, they verbally reported what the dolls did, how they felt, etc.

The Subject-Experimenter Relationship

Once the experimenter felt that the subject had understood and accepted the task, his role was that of a very friendly, sympathetic, interested, but non-interfering, non-suggesting, listener, onlooker and recorder of the child's story. The experimenter unobtrusively recorded without loss of rapport-contact with the child. No attempt was made to conceal from the subject the scoring work or to deny its connection with his play. The experimenter, upon being questioned, would explain to the child, "I like to collect stories; I like your story."

The experimenter never suggested any theme or fantasy actions to the child even when the child did attempt to get play suggestions from him. Such questions for fantasy support were turned back to the subject by such comments as, "It is your

[3]*The author gratefully acknowledges the generous cooperation received from Jane Armbruster of the Paul Revere Center, and from Adela Losch of the Miles School, Cleveland, Ohio.*

story; it is your play; it is up to you what to make it; it can be anything you want it to; you know how to do it"; etc.

The experimenter made a few standardized comments designed to reduce anxiety or inhibition, or to stimulate expressiveness, and to terminate the session in a way meaningful to the child. For example, whenever for purposes of more reliable recording, the meaning of a doll play fantasy could be clarified by a fuller degree of expression of the child's fantasy, the child was encouraged to be more expressive either verbally or manipulatively with such comments as, "Show me what they do," or "Make them act it out," or "Tell me what they are doing." This stimulation of expression was used only on the rare occasions when it became necessary for the understanding of the meaning or direction of the doll actions. But in all cases of any type of stimulation, suggestions of fantasy content were avoided.

In this way the requirement of assuring the same instigating condition for the projective father fantasies of both the experimental and the control groups was thought to be fulfilled. Yet the standardization of the S - E relationship did not interfere with maintenance of a rapport which made the child feel: "Here is a sympathetic, friendly, non-teacher-like, non-authoritative adult with whom I can be free and spontaneous and who likes me and my stories."

Record Taking

The experimenter took a running account of the play fantasies during the three sessions as the subject produced them. He classified the fantasy content into a few pre-defined categories by means of symbols which were entered on a record sheet. After some experience and practice, it was possible to record doll actions and experiences separately for each of the four characters of the doll drama. These doll actions and experiences were the child's fantasies and constituted the recording units. A scoring symbol stood for a single unit of thematic action for a doll character during a fifteen-second interval as indicated by an electric timer (buzzer).[4]

When two or more doll characters were active in any doll-doll interaction, as many symbols denoting the nature of the action were recorded as dolls were involved and the direction of the social interaction between the dolls was indicated by means of arrows. In this way every doll action was recorded under one of the fantasy categories previously defined in the manual.

This system of recording had a degree of reliability of 89.81 per cent average agreement for all categories between the two experimenters who shared in the collection of these data. This estimate of reliability was obtained on twelve pre-experimental doll play sessions with one of the experimenters taking turns scoring the same subjects from behind a one-way vision screen, while the other experimenter recorded while working with the child.

Major Doll Play Fantasies

All doll play fantasies were immediately classified by the experimenter into various categories. The fantasy categories of particular relevance to the present study are given below.

Stereotype Fantasies: Dramatizations of dolls which in content simulate habitual routine actions and experiences that could ordinarily be expected (on the basis of stereotypes of "home" and family life) to be performed by real persons in an analogous actual setting. Stereotyped doll actions and experiences are like photographic reproductions of commonly appropriate, "proper," non-individualistic, social behavior (e.g., polite greetings, sitting down to eat dinner, to listen to the radio, going to bed, using the toilet properly, etc.).

Fantasy Aggression: The child made the doll act or described the doll as acting or intending to act injurious, punishing, disparaging, or depreciative towards another doll, or the child described the doll character as being in an aggressive attitude, nature, manner, or mood, etc.

Aggressive fantasies were subdivided according to the social direction of these

[4] *Thanks go to David Roberts of Western Reserve University for constructing two very reliable timing instruments.*

aggressions, and their severity, e.g., killing was a sub-category of fantasy aggression. Other subdivisions included justification of hostile aggressions, defensive rationalization, aggression in response to commands in the nature of a retort or insubordination.

Fantasy Affection: The doll's actions denoted praise, reward, affection, friendliness, helpfulness towards other characters or enjoyment of another character's company.

Authoritative Fantasies: Included doll-doll interactions of an imperative, directive, ordering, or commanding nature.

Submissive Fantasies: Obliging and submissive doll actions in response to aggressive and/or directive instigation on the part of the other doll characters.

Other categories included such fantasies as Escaping, Chasing, Depressed, and Elated Moods, Sexual Investigation, and Repetitiveness.

Non-Thematic Behavior Categories

In addition to the subject's thematic productions, the experimenters paid close attention to and recorded the idiosyncrasies of the subject's behavior in the experimental situation other than his fantasies proper. Various types of non-thematic behavior were defined, tallied, and ratings of the emotional involvement and degree of inhibitions were made.

The reliability of some of these non-thematic data was found to be too low to be usable here. Individual differences between the investigators with respect to judgments and insights were apparently involved in some of these clinically important observations.

Analysis

The records obtained by the procedure briefly outlined above furnished detailed information of the quality of projective fantasies concerned with inter-personal family relationships. They permitted tabulation and statistical analyses without any post-experimental ratings or classifications.

In so far as the hypothesis that fantasy responses are projective is justified (17), the data present in effect an inventory of the child's actual emotional adjustment to his own family.

Since it was the purpose of this study to see whether this adjustment was influenced by prolonged separation from the father, the data were analyzed to yield a comparison between the father fantasies of the experimental (father-separated) group with the father-fantasies of the control (father-home) group. It was thought that knowing in detail the way father-separated children elaborated about the father in their fantasies would yield some clues as to the psychogenetic importance of the father in the personality development of the child. Consequently, the statistical comparison between the two groups was limited to those fantasies in which the father character was involved.[5]

[5]*In the statistical analysis of the data the author received substantial help from Lorain Hite, graduate student at Kent State University.*

TABLE 1

Mean Frequencies of Projective Fantasies During Three Twenty-Minute Sessions of Doll Play

Fantasy Categories	Experimental Father Absent N=20 Av.	SD	Control Father Home N=20 Av.	SD	Diff.	t	l.o.c.
1. Total Number of Doll Actions of Any Kind	433.85	104.41	461.57	84.78	-27.72.	0.797	N.S.
2. Total Number of Doll Actions Involving Fa.	92.80	27.30	113.01	25.17	-20.21	2.129	< 5%
3. Percent of Doll Actions Involving Fa.	22.49	5.52	25.27	3.37	-2.78	3.501	< 1%

Results: Father Fantasies

The first group of the results of this comparison is given in Table 1. As can be seen, the experimental (father-separated) and the control (father-home) group produced about the same total amount of projective doll play fantasies concerned with family life (Table 1, line 1). There was a slight, but nevertheless significant, preponderance of total number of fantasies involving the father character in the control group (lines 2 and 3). This difference was due to the fact that some of the father-separated children tended to leave the father out of the family scene more often, thus simulating the actual state of affairs in their own homes. This was to be expected on the basis of previous results reported on younger children by Bach (1, pp. 25-26), who estimated that 75 per cent of the normal preschool child's doll play fantasies are rather faithful reproductions of reality conditions.

It would, however, seem misleading to interpret this statistical difference to mean that on the whole the father-separated children left the father out of their fantasies of family life. On the contrary, as Table 1, line 3 shows, one should stress the fact that in spite of actual prolonged absence of the father from the home, the experimental group did include the father in 22 per cent of their fantasies as compared with 25 per cent, the usual chance elaboration of one out of the set of four dolls. The control group indeed showed this 25 per cent. Thus, when strong emotionally conditioned drives find their expression in fantasy, the percentage of reproductive, reality-simulating fantasies is lowered. This was found to be the case also in the school fantasies of the strongly frustrated group of children studied by

Bach (1).

However, the fact that the difference between the experimental and the control groups with respect to total amount of father fantasies was significant would have made it statistically misleading to compare absolute amounts of the father fantasy categories between the two groups, and necessitated the translation of the raw figures into percents using the total number of father fantasies as the base line. In other words, the results were analyzed for differences in the relative distribution of the specific types of father fantasies, since one group (the control) had a greater total of all father fantasies regardless of specific type. The results of this analysis are shown in Table 2 and Figure 1.

Among the sixteen comparisons that were made, eleven statistically significant differences between the father fantasies of the two groups were found. The starred lines in Table 2 and the bars in Figure 1 show the eleven categories of father fantasy that significantly differentiated the father-separated from the father-home children. The experimental (father-separated) group is represented in the figure by the solid black bars.

TABLE 2: EFFECTS OF SEPARATION

Mean Percent-Frequency of Occurrence of Father-Fantasy Categories During Three Twenty-Minute Sessions of Doll Play

All Doll Play Fantasy Categories that Involved the Father	Experimental N=20 Mean %	SD	Control N=20 Mean %	SD	Diff. between means	t	l.o.c.
1* Stereotype Family Life	67.61	11.16	52.97	16.53	+14.64	4.000	< 1%
2 Aggression received by Fa.	5.11	6.16	8.04	6.10	- 2.93	1.230	>20%
3* Aggression from Fa.	4.86	7.14	15.26	9.61	-10.38	3.495	< 1%
4* Affection received by Fa.	6.64	5.26	3.38	3.24	+ 3.32	2.030	< 5%
5 Affection given by Fa.	3.27	3.63	4.65	2.24	- 1.38	1.103	>20%
6* Directions by Fa.	2.08	2.06	4.37	3.23	- 2.29	2.409	< 3%
7 Directions received by Fa.	2.14	0.52	3.82	3.53	- 1.68	0.640	>20%
8 Escape from Fa.	0.38	3.44	1.69	1.23	- 1.78	1.278	>20%
9* Fa. in Depressed Mood	0.00	0.00	1.58	1.05	- 1.58	6.677	< 1%
10 Fa. in Elated Mood	4.58	6.69	2.29	2.20	+ 2.29	0.969	>20%
11* Unclassified, Individual.	3.64	5.14	2.01	2.76	+ 1.63	2.173	< 4%
More Specific Fantasies Included in the Above							
12* Social Recreations (Stereo.)	19.69	7.70	8.28	7.25	+11.41	4.134	< 1%
13* Fa's. Aggr. ag. Children	4.34	6.56	14.75	7.85	-10.41	3.989	< 1%
14* Mo's. Aggr. ag. Fa.	1.28	2.57	4.05	4.60	- 2.77	2.144	< 4%
15* All Fantasy Aggressions Involving Fa. (#2,3,9)	9.89	11.90	24.87	9.68	-14.98	11.523	< 1%
16* Fa. Affection for Children	7.01	5.76	4.08	2.69	+ 3.83	2.174	< 4%

The experimental group has a preponderance of stereotyped fantasies about family life (Table 2, line 1). More specifically (line 12), the father-separated children elaborated more intensively the leisure time living room recreational activities of

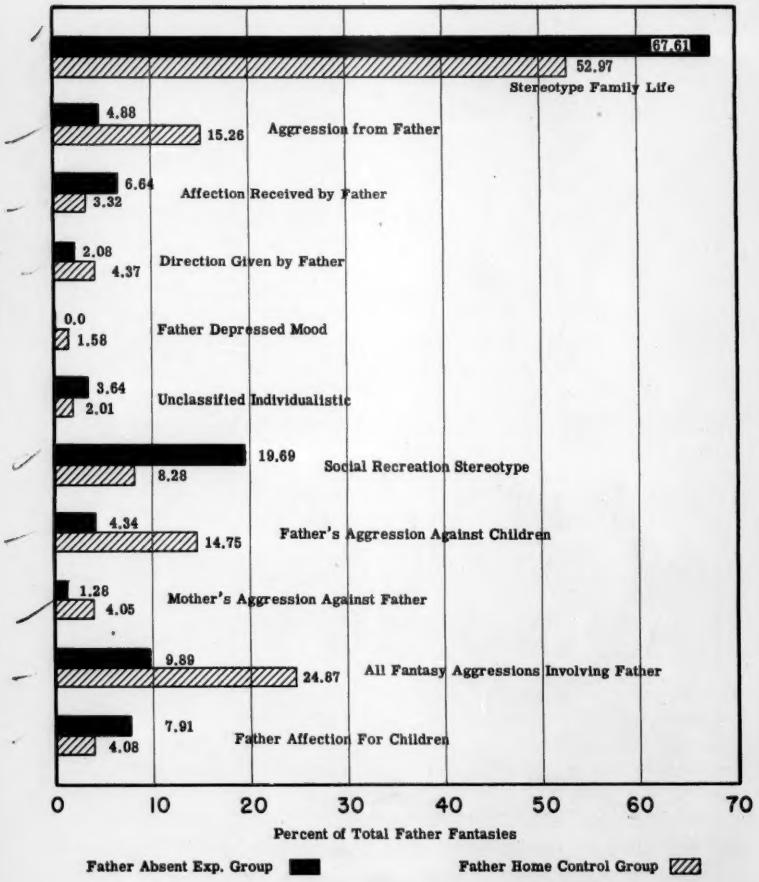

Figure 1. Significant Differences in Father Fantasies of Children.

the family. In these fantasies the father was shown to enjoy sitting with the children and listening to the mother play the piano, or just sitting and reading the paper while the children amused themselves in the living room, etc.

Very significant were the differences found in fantasy aggression. The proportion of the father's aggressive behavior toward both the family as a whole (line 3) and the children in particular (line 13) is less in the fantasies of the father-separated children. The father is also less often the recipient of the mother's hostility (line 14), and no child in the experimental group represented the father as being in a depressive or angry mood at any time (line 9). In general, the father-separated children had relatively fewer aggressive fantasies that involved the father than did the control children (line 15).

The results on the fantasy aggressions of the school age child are similar to Sears' recent finding of reduced fantasy aggression in preschool boys who were separated from their fathers during the war (19).

With respect to affectionate fantasies, it was found that the father-separated group pictured the father as giving more affection to his children (line 16), as well as receiving more affection from his family (line 4).

The experimental group also produced fewer authoritative fantasies that showed the father in a demanding and authoritarian role (line 7).

In summary, father-separated children produce an idealistic fantasy picture of the father, who has a good time with his family and who is enjoyed by them. He gives and receives much affection and has little marital discord. This fantasy-father shows very little hostility and does not exert his authority. The children of the control group, however, living as they do in daily contact with their fathers, elaborate significantly more upon the punitive function of the father and his contribution to intra-family hostility.

In so far as these differences are the result of prolonged separation, they seem to indicate the existence of strong drives for paternal affection, and for a harmoniously functioning father-mother relationship. Why would the child, whose doll play fantasies tend to be simulations of reality, otherwise include the actually absent father in such a large proportion of his thematic production? And since Bach (1) has previously shown that stereotyped-idealistic and repetitive doll play fantasies tend to be diagnostic (projective) of strong positive wishes, the existence of a strong drive for the possession of a loving and generous father is evident from the present data. However, since the fantasies of the experimental children are very similar to

the stereotyped, non-aggressive fantasies found in girls living under ordinary family conditions (1, 16), the pronounced differences between the experimental and the control groups may reflect to some extent the increase in amount and extent of maternal-feminine social stimulation. The theoretical implications of these results are discussed in more detail later, but there is no question about the fact that the projective doll play technique is a rather sensitive indicator of psychological changes brought about by changes in the social environment of the child (1).

Further Results: Sex Differences

The reader will have noticed that the major results of this study were reported for the two groups as a whole without reference to sex differences. This was made possible by the initial equalization of the number and the psycho-sociological characteristics of the boys and girls in the two groups studied. Although the major interest of the writer is in the question of the effect of father-separation on children in general, it is interesting to ask the question whether boys and girls differ in their reaction to this separation factor.

Table 3 presents the results of a comparison made between the father fantasies of the father-separated boys and the father fantasies of the father-separated girls.

TABLE 3: SEX DIFFERENCES

Comparison of Mean Percent-Frequency of Occurrence of Father-Fantasy Categories Between Father-Separated Boys and Girls

All Doll Play Fantasy Categories that Involved the Father	Boys N=10 Mean %	SD	Girls N=10 Mean %	SD	Diff. between means	t	l.o.c.
1* Stereotype Family Life	62.72	13.30	71.64	11.00	- 8.92	5.429	< 1%
2* Aggression received by Fa.	8.41	7.74	1.80	2.45	+ 6.61	6.218	< 1%
3* Aggression from Fa.	7.72	8.70	2.04	2.91	+ 5.68	5,004	< 1%
4* Affection received by Fa.	4.68	4.55	8.60	4.70	- 3.92	3.862	< 1%
5 Affection given by Fa.	7.32	6.85	8.49	4.33	- 1.17	1.050	>20%
6 Directions by Fa.	2.09	2.09	2.21	1.94	- 0.12	0.179	>20%
7 Directions received by Fa.	2.03	2.57	2.26	1.99	- 0.23	0.322	>20%
8 Escape from Fa.	0.45	0.71	0.32	0.63	- 0.13	0.336	>20%
9 Fa. in Depressed Mood	0.00	--	0.00	--	0.00	---	-
10* Fa. in Elated Mood	2.34	3.64	6.83	8.15	+ 4.49	3.939	< 1%
11* Unclassified, Individual.	5.00	6.17	2.28	3.33	+ 2.72	2.656	< 2%
Sub-Categories Included in the Above							
12 Social Recreations (Stereo.)	18.92	9.43	20.47	5.04	- 1.55	1.225	>20%
13* Fa's. Aggr. ag. Children	6.44	8.30	1.84	2.85	+ 4.60	3.773	< 1%
14 Mo's. Aggr. ag. Fa.	1.67	3.30	0.89	1.46	+ 0.78	1.112	>20%
15* All Fantasy Aggressions Involving Fa.	16.14	13.97	3.85	4.81	+12.29	8.523	< 1%
16 Fa's. Affection for Children	3.18	4.02	3.39	3.16	- 0.19	0.213	>20%
17 % of Fa.-Fantasies of all Doll Play Fantasies	23.26	5.45	21.74	5.31	+ 1.52	1.393	>20%

As was expected on the basis of previous studies (1, 16), appreciable sex differences were observed. The nature of these differences is consistent with the previously reported results on younger children: the boys showed a significantly greater amount of aggressive fantasies (Table 3, lines 2, 3, 15) and the girls exceeded in affectionate fantasies (lines 4, 10) and in stereotype (line 1).

Since it seems that these sex differences are general and apparently a rather stable personality factor related to cultural sex-typing (1, 16), it would be misleading to emphasize that the father-separated girl makes the father in her fantasy even less aggressive and more affectionate than does the boy, because one would expect this without the separation factor on the basis of the known sex differences in projective doll play fantasies. Rather, it is possible that school-age children of either sex are about equally affected by father-separation. This is an interesting conjecture, however, which fortunately is receiving further experimental attention (cf. 19).

Further Results: Father-Typing

In order to determine whether stimulus variables in the immediate social environment of the child during the separation period influenced the pronounced idealistic fantasies found in these children, some follow-up analyses within the experimental group were made.

The data gathered in the home interviews included information about maternal "father-typing." Father-typing is a dispositional concept that denotes the general personality characterizations of the father that mothers (or other persons close to the child) give to the child, e.g., "Your father is strong"; "Your father is strict"; "Your father is a hard and mean man"; "Your father is a kind and generous man"; etc.

As was mentioned previously, the mothers of all the children were interviewed. At least two two-hour home visits were made to each of the families, and the instructions for home interviews that H. Champney devised (3, 4) were followed in a modified form. Among the modifications used was an original interview schedule, part of which was designed to record data concerning father-typing. A copy of one of the data sheets on father-typing that was used in these interviews is shown on page 74.

In addition to this direct type of evidence of father-typing, the interviewers rated the father's pre-war behavior on the Fels-Scales on the basis of mothers' reports. This somewhat unorthodox procedure provided an additional opportunity to

SAMPLE-PAGE OF ORIGINAL INTERVIEW SCHEDULE

I. "Father-Typing." How is the father presented to the child by the mother? What kind of a person is he made out to be? Extent to which he is being "used" to motivate child's behavior during his absence.

A. Father is described to S or discussed in presence of S in the ways indicated by the ratings below. (In cases of families where none of these father-typing-ratings fit, describe on back of this sheet.)

F idol; over-imitated	F worthy appreciated	F taken for granted	F criticized; imitation re-proved	F image taboo
F prestige high; income, profession, reputation, achieve-ments	prestige at neighborhood mean		Father's social prestige status low; (disapprovingly stressed)	
Father cornu-copia from whom all blessings flow	F above standard	F adequate provider	F minimal provider	F "loafer" security comes from mother or others
F entire life devoted to family; misses loved ones if absent	F unselfish without self-abnegation	Unemotional acceptance; compromises self-interest	Shuns family responsibility; fled to army, or to lodge and bars	Complete disinterest rejection
F over aggressive, a bully	Father a leader in full control of any situation	F ambivalent variable or neutral	F gentle character, hates army, avoids con-flicts.	F submissive imposed upon, "sissy" at work or in army

B. Anecdotes elaborating the above rating data:

assess maternal attitudes towards the absent father. The interviewer's and the teacher's descriptions of how the children's mothers talked about their absent husbands also gave valuable clues on father-typing, e.g., a typical correlate of unambiguously unfavorable father-typing was a mother's open expression of her contempt of her husband by warning her child "not to be like your father." All these data were used to select the cases in which by all indications the father-typing was unambiguously unfavorable.

Four cases, two boys and two girls, were located where the mothers described the absent father in only depreciative or critical terms, without any positive or favorable comments. In these cases it was felt safe to assume that the children heard only "bad things" about their absent father. There were more cases with some negative father-typing but only in these four was the father-typing devoid of any positive, compensatory

features whatsoever.

In our search for a contrasting group, we again found only two boys and two girls where it was safe to infer from the various interview data that their mothers provided the children with unambiguously favorable, perhaps idealistic father-typing, i.e., these children heard the absent father spoken of in affectionate, appreciative value terms only, and the child was praised whenever his behavior reminded the mother of her husband.

This procedure of selection was somewhat subjective, but since this is a first empirical investigation of father-typing, we had to be content with the poor degree of refinement achieved in this pilot study. The clinical and systematic importance of the possibility that mere verbal symbolization may have social substitute value, warranted the relatively extensive labor considering the few cases.

TABLE 4: FATHER-TYPING

Mean Percent-Frequency of Occurrence of Father-Fantasy Categories During Three Twenty-Minute Periods of Doll Play: Experimental Sub-Groups Only

Fantasy Categories	Fa-Typing Unfavorable N=4		Fa-Typing Favorable N=4		Diff. between means	t	l.o.c.
	Mean	SD	Mean	SD			
1. Aggression by Fa.	8.40	8.37	1.82	1.10	+6.58	3.691	>2%
2. Fa. Aggr. ag. Chil.	7.88	8.80	1.34	1.33	+6.54	3.551	>2%
3. Affec. Given to Fa.	9.31	3.26	1.63	1.69	+7.68	5.820	>1%

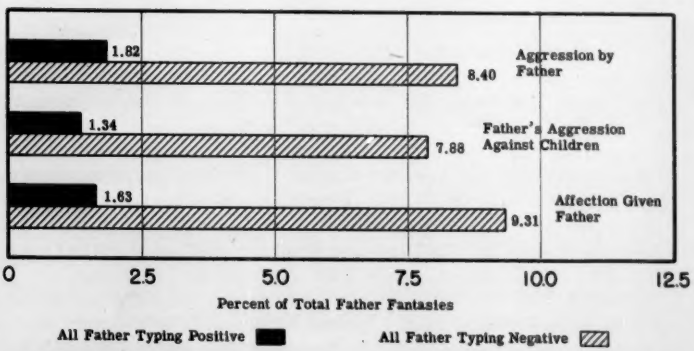

Figure 2. Father Fantasies Of Separated Children With Differences In Mother's Father Typing

Table 4 and Figure 2 show the three statistically significant differences that were found when the two subgroups (father-typing-unfavorable versus father-typing-favorable) were compared along the eleven fantasy categories which had significantly differentiated the experimental group as a whole from the control group. The discovery of these differences is evidence that the nature of the father fantasies that characterized the father-separated children was, in fact, influenced in certain respects by the father-typing variable.

The fantasies of the children with unfavorable father-typing (striped bars in Figure 2) picture the father to be relatively more aggressive, particularly against his children (Table 4, lines 1, 2). At the same time he receives more affection from them (line 3).

Further inspection and study of our father-typing data corroborated the statistically significant finding of curiously ambivalent aggressive-affectionate father fantasies in cases where the maternal father-typing tended to be depreciative.

These results force our attention to the further study of verbal father-typing and mother-typing as a stimulus-variable which in itself can modify the child's emotional relationship to his parents, even though the "typing" may be merely a more or less truthful expression of the degree of marital harmony or discord that exists in the family.

Furthermore, since father-typing is relatively easily controllable, full knowledge of this variable may be of practical value in prophylactic parent-education, in psychotherapy, and in the control of the personality development of children who have lost one or both parents.

Theoretical Considerations

Of systematic interest is the fact that the obtained data make theoretical sense when interpreted in the light of the frustration-aggression hypothesis (5), and the principles of social learning (12).

The biological dependency of the child and the patriarchal characteristics of American society provide the basis for the child's secondary drive for security and affection from the father, particularly strong in the so-called "latent period" in which identification with the father is an important support for the child's social habit acquisition (conscience learning).

While the father is accessible to the child, this drive is, on various occasions, readily reduced, but at other times it is severely frustrated through: 1) the exercise of paternal authority and 2) the fear of rivalry. This interference instigates ag-

gressive motivations, the goal-response to which would be actual hostility toward the father. This overt aggression is, however, at least partially blocked by the anticipation of retaliation, and, therefore, finds a substitute expression in aggressive fantasies (1).

When the father is absent, the drive for affection, security, and companionship has no opportunity to be reduced, and the absence of the father prevents father-instigated interference and the occasion for rivalry. Consequently, there is less instigation for aggressive fantasies, and the severly deprivated drive for paternal affection provides strong instigation for the idealistic, wish-fulfilling fantasies.

The mother as a social stimulus complicates this stimulus-response sequence. She may, through her father-typing, if favorable, further intensify the child's drive for the affection of his father, or, if unfavorable, she may interfere with this drive, perhaps by instigating fear of the return of the "nasty" father, in which case a conflict situation is created that instigates ambivalent, aggressive-affectionate father-fantasies.

This is undoubtedly not the only influence that the mother exerts on the child as a result of father-absence. As a matter of fact, the effectiveness of maternal stimulation, as indicated by the results on father-typing, suggests an alternate explanation of the major results in terms of social learning principles (12). Beyond influencing the child through father-typing, the mother may actually modify the child's personality development in the direction of femininity during the period of father-absence. The father is not available for imitation of or identification with masculine social behavior, and there is now more opportunity to imitate the feminine attitudes, manners, and values of the mother (cf. 20, pp. 153-154). The idealistic father-fantasies of both the separated boys and the separated girls with their stereotyped, affectionate and non-aggressive themes are very similar to the doll play fantasies characteristically produced by girls (in contrast to boys) under ordinary family conditions (1, 16). This "feminization" of the father-separated child's fantasy may then be a reflection of the increased potency of the mother as a social stimulus. The idealistic father-fantasies may, therefore, not only be an expression of the child's wish for an affectionate father but may actually also be symptomatic of a personality reorganization produced by exclusive maternal domination. If this interpretation is a valid one, the results of this study assume some significance with respect to the dynamics of cultural "sex-typing." However, further research into these relationships is required before an empirical evaluation can be made of the differential effects on personality

development of the various stimulus variables that come into play because of father-separation.

Practical Implications

At the time of this writing, problems of family readjustment after war experiences are of acute interest (8). The results of the present investigation suggest some insights of practical value pertaining to these problems.

The stereotyped, idealistic fantasy picture that the child has of the absent father may initially be a handicap in the re-establishment of a realistic father-child relationship. The child may experience a certain degree of disappointment over the wished for reunion. The father's resumption of domination and authority would certainly come in conflict with the child's idealistic expectations. Consequently, the instigation of feelings of paternal rejection is a strong possibility. The father can be expected to be puzzled by this and may develop the impression that his child has become estranged from him. This may lead to some disturbance of the morale of the family group.

But these unfortunate consequences of the child's way of having previously adjusted to separation will most likely be a temporary episode in the readjustment to reality, and the possibility of a seriously ineffective adjustment to the situation can be avoided by explaining to the returning father and to the mother the nature of the psychological forces at work in their child's mind.

Therapeutic Implications

The fundamental question of the effect of fantasy experiences on the development of overt behavior characteristics deserves a brief comment. It is a reasonable hypothesis based on observed effects of play therapy (18) that fantasy expressions have behavior modification potentialities similar to gratifying and painful reality experiences.

This can be so by virtue of the cathartic and/or anxiety characteristics of the fantasy response. These characteristics, together with the imitations and identifications noticeable in children engaged in doll play fantasies, should provide sufficient conditions for at least vicarious social learning.

To be sure, these behavior processes still need patient and careful empirical clarification, but such research effort seems justified by the indication that many of the factors that influence a child's fantasy also influence his actual personality development. Consequently, fantasy control can become one of our

most practical tools in our efforts to control personality development. The technical complications involved in the study and instigation of children's fantasies should not deter from this all-important possibility.

SUMMARY

The father fantasies of twenty father-separated children six to ten years of age and those of twenty control, father-home children, are compared by means of a standardized doll play technique. The father-separated children produced an idealistic and feminine fantasy picture of the father when compared with the control children, who elaborated the father's aggressive tendencies. The nature of the maternal father-typing seemed to influence this difference. Practical, clinical and theoretical implications of these results are discussed.

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BIOLOGICAL AND MEDICAL STUDIES AT THE SAMUEL S. FELS RESEARCH INSTITUTE[1]

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The Fels Research Institute was established in 1929 by Mr. Samuel S. Fels as an expression of his interest in people and the factors which constitute human effectiveness. It has undertaken a developmental study of structure, function and behavior in relation to environment and heredity. Because adult man is the product of innumerable environmental influences and their impact from conception to maturity upon inherited germ plasm characteristics, the Fels program was designed to permit the study of individuals throughout this age range.

As the Institute was initiated in 1929, it had a staff of three people. As techniques and methods were developed and data collected, the Institute grew. Its staff in 1941 consisted of twenty-five persons including assistants. Originally financed personally by Mr. Fels, in 1935 the Institute was taken over by the Samuel S. Fels Fund of Philadelphia. In 1945 the Institute which had completed its original term of existence, was placed on a continuing basis with an expanded budget and staff. A completely new research building providing greatly increased space and excellent equipment is now to be constructed.

The Institute is studying approximately three hundred white children and their families, who live in neighboring communities. Participation in the study is voluntary and participants are unselected, except that preference is given to families showing a reasonable prospect of permanent residence in this region.

Included in the disciplines represented on the Institute's staff are: medicine, anthropology, psychology, genetics, biochemistry, biology, and psycholphysiology. We are, of course, studying the whole child. That good but somewhat hackneyed term often leaves in the minds of an audience rather amorphous concepts of what really constitutes "whole child" research, beyond describing individual children in terms of every readily measurable characteristic from height to appetite. While such multidiscipline and longitudinal description of the whole child is valuable in itself, perhaps it is more important to use such data to answer questions about the nature, mechanics and predictability of individual differences in human beings.

I have selected from our Fels studies certain projects which

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will illustrate what we are attempting to accomplish. One of the studies I shall describe is that of the genetics of individual growth patterns of height and weight. Group growth curves are, of course, an average of a number of individual curves. Only occasionally does the curve of any individual child conform closely to the group pattern. (Slide I.) Instead he is likely to arrive at his end points of growth by means of one or more periods of rapid and slow growth, the temporal spacing of which is a highly individual characteristic. These and other interesting growth characteristics which children exhibit are often not readily explainable, either in terms of early or late sexual maturation or because of environmental factors, such as illness or nutrition. Children often change their body types insofar as height-weight relationship goes, at least once during the first ten years of life, and may reverse themselves twice or more.

Slide II shows the patterns of growth of a pair of monozygotic twins. The likeness of these curves is obvious and the periods of slow and rapid growth correspond very closely.

Slide III shows the growth curves of a pair of siblings, both of whom undergo violent periods of deceleration and acceleration in height, appearing at approximately the same period of life and who have also very similar changes in weight curves.

In order to study familial patterns, it is important to compare the similarities between identical twins, siblings and unrelated children. We have material for such studies of the characteristics of growth progress, because in our group the majority of families have more than one child and some have as many as seven siblings, all of whom have been observed since birth at the Fels Research Institute. Our work to date in this area suggests that aside from severe, prolonged malnutrition or illness, children tend to follow a predetermined growth curve which is resistant to minor differences in nutrition and the usual diseases of childhood. In other words, we believe that inheritance plays a large part in determining at what periods of a child's life he grows rapidly and at what periods he grows slowly in various body dimensions, ossification, teeth and other things.

One of our biochemical interests is an attempt to measure, if possible, the biochemical-physiological characteristics of constitution which, inherited or acquired, may determine or be correlated with the nature of such growth curves as I have shown previously. In other words, we hope to determine some of the physiological-biochemical characteristics of periods of slow growth and rapid growth and to learn which are inherited.

Annual or semi-annual determinations of the excretions of sex hormones and other ketosteroids, blood enzyme levels,

blood vitamin levels, vitamin load tests and other measures of this type constitute an important part of our research program and are the materials now available from which to attempt to fashion an understanding of the mechanics and significance of differences in the growth process.

A few of the many uses to which we are putting our biochemical data are studies of:

1. The normal ranges of blood enzyme levels.
2. Age changes in ketosteroid excretion levels.
3. Growth correlates of vitamin status.
4. Relation of ketosteroid excretion to body type.

All of us who have been studying individual differences in children have been frustrated by our inability to measure adequately individual differences in the biochemical functioning of human beings. This failure has severely limited our attempts to find the origin of such differences in structure and behavior.

Longitudinal biochemical studies of children are expensive. Furthermore, adequately accurate methods for measuring many important factors did not exist in the past. Some have been made available, but many still do not exist and must be devised. In the last few years, fairly satisfactory methods for measuring some of the hormones, enzymes and vitamins have been developed through the use of colorimetric techniques, the spectrophotometer, etc. Another and not unimportant point is that any study of normal children may not elect to use techniques which require the periodic veni puncture of children and the withdrawal of considerable quantities of blood. Children don't like that sort of thing, and in the main won't stand for it if it is done at frequent intervals. The development of micro-techniques whereby several enzymes, ascorbic acid, serum protein, blood sugar in addition to red and white cells, hemoglobin and differential can all be measured from a few drops of blood taken from a child's finger, is therefore a tremendously important advance. The emphasis we are putting on the biochemical aspects of growth and development is the direct result of this advance in techniques.

Broadly put, we should hope to measure the ability of individuals to effectively survive in stress environments. It seems no more unreasonable for an individual, when selecting his life station and vocation, to take into account his so-called psychosomatic constitution than it seems unreasonable for him to take into account his level of intelligence and special aptitudes before attempting to study law or medicine.

These examples of our interests and efforts in the biochemical-physiological-medical areas of the study of human development do not constitute the whole research program of the

Fels Research Institute. They do represent, however, some of our basic studies which we hope will contribute toward the understanding of human development and function.

CHILD DEVELOPMENT IN RELATION TO COMMUNITY SOCIAL STRUCTURE[1]

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This is a summary of a group of studies which are being conducted under the auspices of the Committee on Human Development of the University of Chicago. These studies have the common factor of attention to community social structure as a powerful influence in child development.

The need for studies which emphasize the effects of the social environment on child development has become very clear in recent years. Of the three general approaches to the study of children - the psychological, biological, and sociological - the excellent research of the past thirty years has been long on the first two and short on the sociological.

At the University of Chicago a number of people from the departments of sociology, anthropology, education, and psychology have been working on collaborative, interdisciplinary studies which stress the factors of culture and community social structure in child development. The faculty members most directly concerned are Professors A. W. Brown, E. W. Burgess, Allison Davis, R. J. Havighurst, V. E. Herrick, F. A. Kingsbury, W. C. Seyfert, Caroline Tryon, R. W. Tyler, and W. L. Warner.

Basic Working Concepts

By community social structure is meant the various social groups in the community, their relationships to one another, and the change of these relationships with time. Insofar as the various social groups have markedly different habits and values - that is, insofar as the various social groups have different cultures - the structure of the community is a factor of great importance in causing the children of different groups to grow up so as to preserve these cultural differences.

The central working concept in these studies is that of social class. A social class is a group of people who participate together socially on intimate terms, or who would be willing to do so. Social class is a scientific refinement of the concept of

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socio-economic status, more useful because it divides people more definitely into different cultural groups. With the aid of the concept of social class, supplemented by those of ethnic and religious groups, it is possible to divide the people of a modern community most cleanly into separate culture groups.

The concept of social mobility is also essential in studies of modern communities. Social mobility is movement from one social class to another, a phenomenon which is characteristic of a democratic society. There are always some people in a modern democratic society who are in the process of adopting habits, manners, values, and goals of a social class different from the one into which they were born. They are mobile people who give the society its fluid, non-stratified aspect.

Current Studies

Using these working concepts of community social structure, the group at Chicago is making or has recently completed the following studies.

1. Child Development in a Typical Midwestern Community. The Committee on Human Development has selected a small midwestern city and its rural trading territory as a site for an extensive series of studies. The community comprises about half a county, with a population 11,000. It is typical of the agricultural-industrial communities which occur with great frequency in the midwest. By a number of census criteria this community falls close to average for its group.

Studies of the social structure of this community have been underway for four years. The social class composition of the city is now fairly well known, some three-fourths of the residents having been assigned to social class positions on the basis of information concerning their social participation and their socio-economic status. Special studies have been made of several ethnic and religious groups. The principal organizations of the community have been charted. At present one of the rural townships is being studied intensively, and its social organization will be related to that of the city.

These studies of social organization serve two purposes. They contribute to the growing fund of knowledge which social anthropology is building up concerning modern America; and they furnish the necessary background information for studies of child development in relation to community social structure.

Two groups of boys and girls are the subjects of the Study of Character Formation in an American Community. All the children born in the years 1926 and 1932 are included in this

study. The 1926 group were put under intensive investigation during the years 1943-1944, when most of them were in the junior and senior years of the high school. The 1932 group has been followed since 1942. Although the initial emphasis was on factors most closely related to moral character, the scope of the study has expanded to include the entire span of personality. Techniques range from the usual tests of attitudes and abilities to projective techniques such as the Rorschach and Thematic Apperception tests. The interview is a mainstay. The variables of social status and social mobility are being related systematically to the findings concerning character and personality.

During the course of this study, the school has emerged as a factor of great importance in the formation of character and personality of these children. It combines with the family to create the social environment of the child. The school is essentially middle-class in its values, its teaching, and its staff. The middle-class child finds the school reinforcing the goals, attitudes, and habits he has been taught in the home. On the other hand, the lower-class child finds the school attempting to teach him ways of behaving and believing which are not entirely what he has been taught at home. This child may turn toward the school, encouraged by his parents who want him to get from the school some of the skills and attitudes they cannot teach him, or he may turn against the school, and reject what it stands for, including its moral precepts.

Publications from this study will commence to appear in 1947.

2. Child-rearing Practices in Relation to Social Class and Color. This study has just been completed and will soon be published by Allison Davis and Robert J. Havighurst. A report on that part which deals with social class and child-rearing practices has been written by Martha C. Ericson and will appear in the American Journal of Sociology in 1946.

Two hundred Chicago mothers of young children were interviewed by a guided interview method concerning their practices in rearing their children. There were fifty each in four categories: middle-class white and Negro, and lower-class white and Negro.

The results show that the same types of differences exist between middle and lower-class Negroes as between middle and lower-class whites. Middle-class parents are more rigorous than lower-class parents in their training of children for feeding and cleanliness habits. They also expect their children to take responsibility for themselves earlier than lower-class parents do. Middle-class parents place their children under a

stricter regime, with more frustrations of their impulses, than do lower-class parents.

3. Parental Ideologies in Relation to Social Class. In a study completed in 1945, Evelyn Millis Duvall compared the concepts of "a good parent" and "a good child" that are held by women of four social class levels in Chicago, ranging from upper-lower class to upper-middle class. She found a systematic variation as her groups went up the social scale, regardless of whether they were Jewish, non-Jewish, or Negro.

4. Intelligence Test Performance in Relation to Social Class. It is generally understood that the ordinary verbal tests of intelligence consist mainly of problems and items drawn from the middle-class culture, and therefore probably penalize lower-class children, who do not have as much familiarity as middle-class children have with the vocabulary and the problem-situations that occur in the tests. Nevertheless, these intelligence tests are often used as a basis for assigning children to classes which are thought to be "homogeneous" in mental ability; furthermore, the tests are often used to decide what kind of curriculum a child should follow and what kind of educational opportunity is best fitted to his needs.

In order to evaluate more objectively the social-class factor in performance and intelligence tests, a project is now in progress which involves the testing of all the 9-, 10-, 13-, and 14-year-olds in a midwestern city of 100,000. All these children have been given five of the most widely used paper and pencil tests of intelligence. The same children are being located as to social status. Eventually an item analysis will be made of all the test items, for three groups of children at each age: upper-middle class, lower class of native or "old American" parentage, and lower class of ethnic parentage. Thus will be found the test items and types of items which differentiate most sharply and least sharply between children of various social classes.

5. A Comparative Study of the Development of Indian Children. A study of the development of American Indian children has recently been completed, with many of the same techniques that are being used in the study of children in a midwestern community. Children of five Indian tribes, mainly in the Southwest, were the subjects of this study. Thus it is possible to compare Indian children with white children and Indian children of various tribes with one another. Here the emphasis is upon cultural differences between societies, rather than upon cultural

differences between social classes within a given society.

The results of this study are being published in a series of tribal monographs* together with journal articles describing the results from specific techniques.

*Laura Thompson and Alice Joseph, The Hopi Way, University of Chicago Press, 1944.

Gordon Macgregor, Warriors Without Weapons (Sioux), University of Chicago Press, 1946.

Dorothea C. Leighton and Clyde Kluckhohn, The People and Their Children, A Study of the Navaho Indians, 2 volumes, Harvard University Press, 1946.

Alice Joseph, Rosamond Spicer, and Jane Chesky, The Desert People, A Study of the Papago Indians, University of Chicago Press (In Press).

PARENTS' ATTITUDES ON CHILD BEHAVIOR: A REPORT OF THREE STUDIES[1]

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With the improvement of research techniques, clearer insight into the factors in the environment which determine the child's behavior is being gained. A shift in the approach to the problem of personality has brought new understanding. At one time the behavior of the individual was viewed as possessing in, and of itself, the characteristic of truth and was judged mainly in terms of its logicality. Not only was there right and wrong behavior for a particular situation, but the behavior itself was felt to inhere directly in the situation or be a direct product of it. Situation is here used in the restricted sense to refer to stimulation immediately present at the time or just prior to the occurrence of the behavior.

We now have also moved from the study of the limited and specific situation to the study of contexts; both those which operate over a long period of time, and those which operate for a short period of time. A context operating over a substantial period of time produces effects in the behavior of children which are revealed in permanent, continuing or repeated tendencies of the child to act consistently in a variety of situations. On the basis of continuous or repetitive exposures, the child develops an image of himself, a level of aspiration, a point of view, or consistent attitudes with respect to his environment, which he will reflect in his behavior towards other individuals or his surroundings.

If, in some manner, the immediate situation can be freed of its constraints or limitations, these underlying trends may become manifested. In many, and perhaps most situations, organized responses appear, much as you put a penny in the slot and get a stick of gum. Skills and knowledges have become dissociated from the underlying motivating devices and, because they have acquired autonomy, reveal little or nothing of personality. Thus, if we ask a child the question "What is two plus two?" the answer four or even the wrong answers, five or three, are

[1] *Paper presented at a general meeting of the Society for Research in Child Development in St. Louis, Mo., March 29, 1946. Because of time restrictions, this report covers only a limited number of the studies recently completed or now in process at the Institute of Child Welfare.*

ones that have been set and organized over a period of time. If, however, the constraints inherent in the situation are removed to permit some free play of expression, some opportunity of giving vent to feelings and spontaneous actions, we come nearer securing a picture of the child as he is. We are learning to use the unstructured and free situations as sources of scientific information about the individual.

I wish to describe three extensive studies, one of which is still in process, which are concerned with the relation between parents' attitudes and the goals they set for their children and the behavior of children among their fellows. I shall concern myself with general trends, rather than detailed statistics.

Dr. Radke,[2] who studied young children, obtained data from both parents of four- and five-year-old children by interview and a questionnaire, which covered many aspects of the parents' relations with their children and gave insight into the parents' philosophy as well as their ideas of their specific practices. For the children there was an interview about home practices and standards. Starting with such questions as "Tell me what is a good boy?" "What is a naughty boy?" she moved on to two projective techniques, in one of which the child represented or played out the relations within the family with dolls, and in the other of which he reacted to pictures showing typical family scenes both positive and negative in character. In addition, the children were tested for compliance to authority in an experimental situation, and teachers' ratings on the behavior of the children in school were obtained. Included in the questionnaire for the parents were questions which sought information about their disciplinary methods used with their own children as compared to those used on them as children of the preceding generation. A trend toward much less severe and much less emotional discipline with the change in generations, together with much greater respect for the child's personality, is revealed.

The data show that the children have a reasonably definite conception of their parents. If the child's view of the parents is contrasted with the parent's view of himself, it is clear that the child perceives the parent as much more severe in discipline than the parent conceives himself to be. The child looks upon the parent as the rightful authority but most frequently criticizes the parent for interference in the child's activities. The behavior patterns of the preschool children show patterns that are

[2] *This study is soon to appear as Radke, Marion J. Relation of parental authority to children's behavior and attitudes. (Institute of Child Welfare Monographs No. XXII.) Minneapolis: Univ. of Minnesota Press, 1946.*

related to the home atmospheres. Thus, significant differences in the favor of the democratic versus the autocratic atmospheres are shown in getting along with others, in considerateness, and in emotional stability; in favor of freedom-giving versus restrictive discipline atmospheres are shown in rivalry, in popularity and in colorfulness; and in favor of mild versus the severe punishment atmospheres are shown in talkativeness, rivalry, affection, considerateness and sensitivity. The choices which the child makes in the picture techniques are related to major aspects of his behavior and home life. The pictures give the child an opportunity to externalize his personal reactions to the home situation. While the doll play in this group of fairly normal well-adjusted children gave significant insights into the lives of some children, it proved to be of somewhat limited usefulness for group comparisons.

The second study by Miles[3] concerns social adjustment and leadership behavior at the adolescent level. In a community of 7,000 people with a high school population of 500 children, the children were divided into six groups on a basis of a multiple criterion based on five categories: (1) actual record of leadership positions in school and community, (2) a "Whom would you choose" blank, (3) a "Guess who" blank, (4) teachers' classification, and (5) an activities blank. Seventy children, 38 boys and 32 girls, were selected on the basis of these criteria and divided into the following groups: (1) successful leaders, (2) attempted leaders, (3) followers, (4) voluntary non-participants, (5) overlooked, and (6) outcasts. The children were given personality tests (the Bell Adjustment Inventory and the Rundquist-Sletto Survey of Opinions). Both parents, i.e., the father and the mother of each child, were interviewed separately. Each filled out a blank describing his attitudes or opinions with reference to home practices and chose from hypothetical descriptions of children on cards those descriptions which they wanted their children to be like and those they did not. There is available then for each child a record of his social relations to the groups, his own scores on adjustment inventories, together with important data with regard to parents' attitudes and conception of home training along with sampling and face-sheet data on parent education, socio-economic status, etc. The results indicate significant relation between the social behavior of the children and the socio-economic status and education of their

[3] *Miles, Katherine A. Relationship between certain factors in the home background and the quality of leadership shown by children. Ph.D. thesis. University of Minnesota, September, 1945. (To be published later.)*

parents; a result consonant with the literature. They also indicate a very definite relation between the parents' opinions with regard to the training of the child and the status the child achieves in his own social group and a significant relationship between personality measures and the status achieved in the social groups. When the scale for parents' opinions and practices was broken down into sub-scales, measuring (1) overprotection, (2) dominance, and (3) encouragement of social development, there is also a significant relationship to the child's position in his social group. The results indicate rather clearly that a variety of factors in the context of a child's life are of some relation to the behavior which he shows in his relations to other children and both in turn are related to personality measures. When an item analysis was run between the 121 separate items on the attitude scale, and the 66 on the "Choose your child" scale and an outside criterion based upon the children's behavior in their social groups, interesting relations were found. A second item analysis, based on the correlation of the separate items with total score, also yielded significant results.

If we look at the particular items on the parental attitude scale which seem to have very high value in predicting parental child behavior, we find items such as:

"If a twelve-year-old receives an allowance, his parents should plan with him in detail how it is spent."

"A parent should feel free to read a high school child's letter without first asking permission."

"Children under eight years old should not be allowed to climb trees for fear of broken bones."

Items which have no or little discriminative value are ones such as these:

"Parents should carefully supervise the friendships of adolescent boys and girls."

"Parents should not allow children under twelve years of age to play with undesirable companions."

"Girls over eight years old should make their own beds."

"No parent should ever be satisfied with his child unless he is in some way a leader."

On the "Choose Your Child" scale, typical items which have high discriminative value, in terms of child behavior, are:

"This child cannot stand any form of adverse criticism."

"This child is persistent even in the face of difficulty."

"This child is so tactful that he has unusual ability to get along with other children."

Typical items with no or little discriminative value are:

"This child is easily discouraged when facing difficulties

which can be solved by the ordinary child."

"This child is always good-humored and pleasant to be with."

"This child is not forward; he never pushes himself to the front in any group."

"This child is so cautious and careful that he weighs all possibilities before he finally reaches a decision."

It is interesting to look over the items that discriminate and those that do not. In advance, it would be very difficult to tell which ones will and which will not; in fact, there is no a priori method by which they can be selected. Nevertheless, they do hang together in patterns and, after selection, seem to have some logicality. It seems clear to me that such statements given cannot be interpreted in terms of right or wrong or in a precise way as indicating what the actual practices within the particular family are. They do indicate how parents feel and how they verbalize their feelings about children, and picture indirectly their goals and aspirations.

I quote from the Miles' report: "Attitudes of parents appear to be crucial factors which are closely related to the social behavior of children. Parents of successful leaders show outstandingly different attitudes from the parents of other groups of children. The contrast is most marked when they are compared with parents of asocial children, especially parents of outcasts and overlooked children. In general, parents of successful children are less inclined to protect children from the normal risks of life, to shield them from the normal responsibilities of life and to prevent them from developing an adequate degree of independence which is so necessary for good mental health and normal functioning in the social group. Also, they tend to be less restrictive in the degree of control which they exercise over the child. Much more leeway is allowed the children in making decisions, using judgment and experimenting with new situations. Also the individual personality is given far more respect - his rights and his opinions are given consideration in the family group. In addition, parents of successful children appear to possess superior ability in evaluating forms of child behavior and characteristics of child personality which are desirable for the optimum development of the child himself." (p. 228)

The third study by Frank Hansen in the series is now in process. Essentially it consisted of taking the instruments devised in the Miles' study at the adolescent level, particularly those relating to parents' opinions with regard to practices and ideals for their children and those developed in the Radke investigation, consisting of pictures presenting family situations and child-adult situations, the Radke attitude scale and doll play

procedures, and applying them to the population of a summer camp composed of children of elementary school age. The results obtained will be checked against the social behavior of the children in their groups, their relations with counselors and their relations with camp officials. From this we not only expect to get a picture of the inter-relationships between the Radke techniques and the Miles' techniques, but also to obtain substantial information on the child at the elementary school level - an age level somewhat neglected in the past as an area for research on problems of this type.

Some generalizations can be made from the studies already made which may well be verified when the Hansen study is completed. These are:

1. The child has definite impressions of his parents and has formed an image or concept of them. This can be revealed in normal children by modified projection techniques. The major image or concept is often very different from what the parents themselves would expect. This concept tends to emphasize the disciplinary and management controls exercised by the parents, rather than their positive approaches or affection for the child. The child tends to see parents more as frustrating than as facilitating beings.

2. Parents have very definite attitudes with respect to the management of children. These attitudes cluster in patterns and make up a context from which any single item may diverge, without affecting the major relations in the whole series. There is a relation between the behavior of the child in his own social group with his peers and the parents' opinions or attitudes.

3. The parent also has an idealized child against which he compares or rates the behavior of his own child. This ideal varies with the education and socio-economic status of parents, as well as with their attitudes and opinions on matters of training children. There is a relation between the parents' concept of the ideal child and the behavior of the child in his own social groups.

4. There is a relation between children's behavior in social groups and scores made on personality measures, and between the parents' attitudes, opinions and goals for children and the scores made on personality measures.

5. The relations are clearest and most distinctive for the children who are most distinctive in social behavior, i.e., for successful leaders and the overlooked or social outcasts.

6. Some of the methods here described give promise of usefulness in measuring or studying contexts. It would seem to be most appropriate not to regard them in terms of logicality, but to work with them in terms of empirically determined patterns

or clusters, and to explore the possibilities of differential scoring for different items or responses.

Contents for March-June

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